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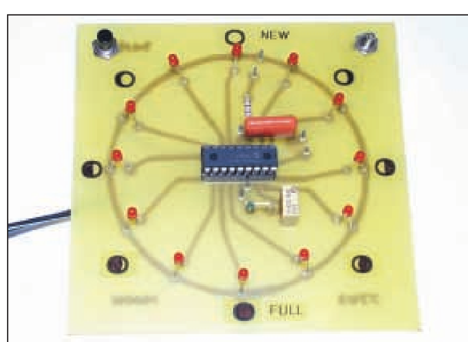
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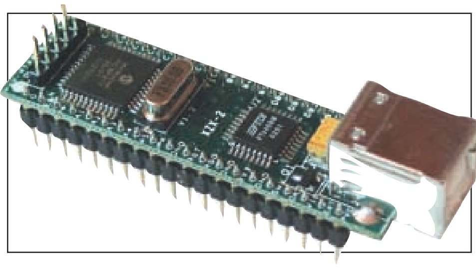
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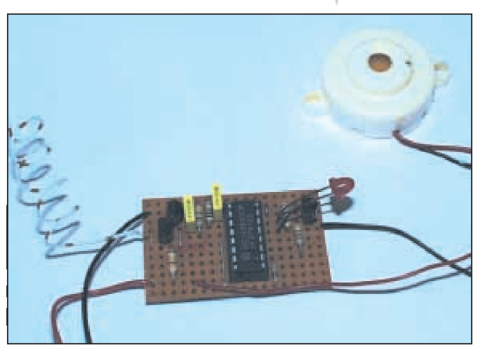
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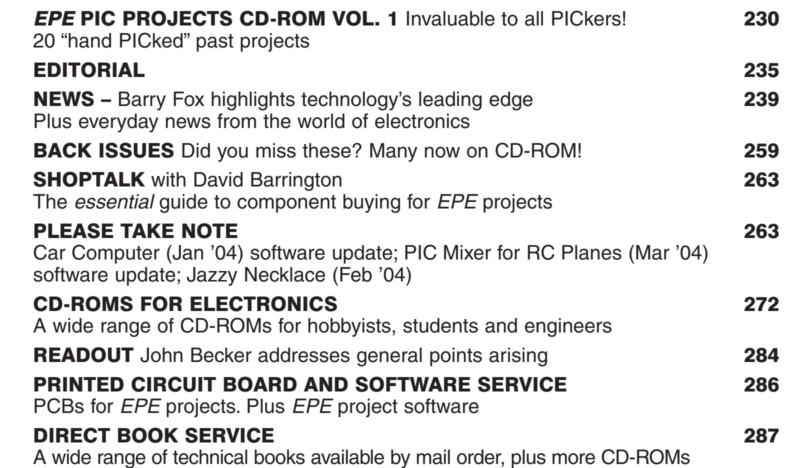
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NEXT MONTH

BEAT BALANCE METAL DETECTOR



A new genre of metal detector?
This project was born out of the intuition that not everything had been thought of in terms of metal detector design. To the best of our knowledge, this project represents a new genre of metal detector, being a hybrid between beat frequency operation (b.f.o.) and induction balance (i.b.). The author has dubbed it "beat balance", or BB for short, thereby giving a nod to each of the two principles which underly it.
The result is a very simple design that is capable of greater sensitivity than that of a b.f.o. detector whilst offering high levels of immunity to voltage and temperature variations and to ground mineralisation, together with good discrimination.

LOW-FREQUENCY WIEN-OSCILLATOR

This article describes and gives full constructional details for a very useful low-frequency signal generator that is simple to make at low cost. Standard-sized components are used to provide a functional and reproducible piece of electronic test equipment.
Powered by a nine volt battery at 10mA, it produces a sinusoidal signal of reasonably constant amplitude at about two volts peak-to-peak over a frequency range of approximately 10Hz to 140kHz.

IN-CAR LAPTOP PSU

A boost switching regulator design to allow a laptop computer – typically requiring between 14V and 23V – to be powered from a car battery or other 12V source. The design provides a stabilised output with an efficiency of between 83 and 90 per cent.

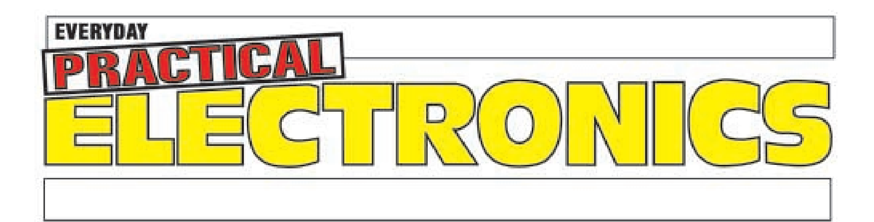
COPING WITH LEAD-FREE

Lead will soon be phased out of electronics, but there is no "drop-in" replacement for our trusty old 60/40 rosin-cored solder. Worse still, the new lead-free technology is not fully compatible with traditional lead-based components. Lead will be banned in most electronics products from 2006.
Unfortunately, the changeover will require more than simply reaching for the new Pb-free solder and dumping the old stuff. The legislation is far reaching and even threatens the use of colophony (rosin) – our favourite flux. The very components we buy and the p.c.b.s we use could soon be lead-free finished. The soldering characteristics will be different and will vary as no single finish yet dominates the market.
We might have expected good compatibility between lead-free solder and the lead-based finish on present components, but to add to our problems, even slight amounts of lead contamination have deleterious effects on lead-free technology. This article investigates the problems, developments and probable solutions.



TEACH-IN 2004 – PART 7 MOISTURE DETECTION AND RADIO LINKS

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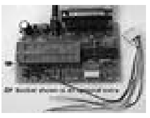
Programmer Accessories:
40-pin Wide ZIF socket (ZIF40W) £15.00
18VDC Power supply (PSU201) £5.95
Leads: Parallel (LEAD108) £4.95 / Serial (LEAD76) £4.95 / USB (LEADUAA) £2.95

NEW! USB 'All-Flash' PIC Programmer



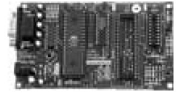
USB PIC programmer for all 'Flash' devices. No external power supply making it truly portable. Supplied with box and Windows Software. ZIF Socket and USB Plug A-A lead not incl.
Kit Order Code: 3128KT – **£29.95**
Assembled Order Code: AS3128 – **£39.95**

Enhanced "PICALL" ISP PIC Programmer



Will program virtually ALL 8 to 40 pin PICs plus certain ATMEL AVR, SCENIX SX and EEPROM 24C devices. Also supports In System Programming (ISP) for PIC and ATMEL AVRs. Free software. Blank chip auto detect for super fast bulk programming. Requires a 40-pin wide ZIF socket (not included)
Kit Order Code: 3144KT – **£54.95**
Assembled Order Code: AS3144 – **£59.95**

ATMEL 89xxx Programmer



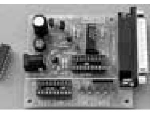
Uses serial port and any standard terminal comms program. 4 LEDs display the status. ZIF sockets not included. Supply: 16VDC.
Kit Order Code: 3123KT – **£29.95**
Assembled Order Code: AS3123 – **£34.95**

NEW! USB & Serial Port PIC Programmer



USB/Serial connection. Header cable for ICSP. Free Windows software. See website for PICs supported. ZIF Socket and USB Plug A-A lead extra. 18VDC.
Kit Order Code: 3149KT – **£29.95**
Assembled Order Code: AS3149 – **£44.95**

Introduction to PIC Programming



Go from a complete PIC beginner to burning your first PIC and writing your own code in no time! Includes a 49-page step-by-step Tutorial Manual, Programming Hardware (with LED bench testing section), Win 3.11–XP Programming Software (will Program, Read, Verify & Erase), and a rewritable PIC16F84A that you can use with different code (4 detailed examples provided for you to learn from). Connects to PC parallel port.
Kit Order Code: 3081KT – **£14.95**
Assembled Order Code: AS3081 – **£24.95**

ABC Mini Microcontroller Board



Currently learning about microcontrollers? Need to do more than flash a LED or sound a buzzer? The ABC Mini Starter Kit is based on ATMEL's AVR 8535 RISC technology and will interest both the beginner and expert alike.
Beginners will find that they can write and test a simple program, using the BASIC programming language, within an hour or two of connecting it up. Experts will like the power and flexibility of the ATMEL microcontroller, as well as the ease with which the board can be "designed-in" to a project.
The ABC Mini STARTER PACK includes everything you need to get up and experimenting right away. On the hardware side, there's a pre-assembled ABC Mini Board with parallel and serial cables for connection to your PC. Windows software included on CD-ROM features an Assembled, BASIC compiler and in-system programmer.
Order Code ABCMINISP – **£49.95**
The ABC Mini boards only can also be purchased separately at £29.95 each.

Controllers & Loggers

Here are just a few of the controller and data acquisition and control units we have.
See website for full details. Suitable PSU for all units: Order Code PSU203 – **£9.95**

Rolling Code 4-Channel UHF Remote



State-of-the-Art. High security. 4 channels. Momentary or latching relay output. Range up to 40m. Up to 15 TXs can be learned by one Rx (kit includes one Tx but more available separately).
4 indicator LEDs.
Rx: PCB 77x85mm, 12VDC/6mA (standby).
Two & Ten Channel versions also available.
Kit Order Code: 3180KIT – **£41.95**
Assembled Order Code: AS3180 – **£49.95**

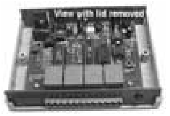
Computer Temperature Data Logger



Serial port 4-channel temperature logger. °C or °F. Continuously logs up to 4 separate sensors located 200m+ from board. Wide range of free software applications for storing/using data. PCB just 38x38mm. Powered by PC. Includes one DS1820 sensor and four header cables.
Kit Order Code: 3145KT – **£22.95**
Assembled Order Code: AS3145 – **£29.95**
Additional DS1820 Sensors – **£3.95 each**

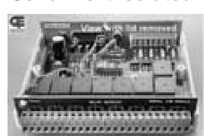
Most items are available in kit form (KT suffix) or pre-assembled and ready for use (AS prefix).

NEW! DTMF Telephone Relay Switcher



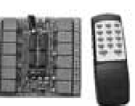
Call your phone number using a DTMF phone from anywhere in the world and remotely turn on/off any of the 4 relays as desired. User settable Security Password, Anti-Tamper, Rings to Answer, Auto Hang-up and Lockout. Includes plastic case. 130 x 110 x 30mm. Power: 12VDC.
Kit Order Code: 3140KT – **£39.95**
Assembled Order Code: AS3140 – **£59.95**

Serial Port Isolated I/O Module



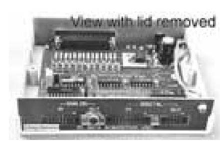
Computer controlled 8-channel relay board. 5A mains rated relay outputs and 4 opto-isolated digital inputs (for monitoring switch states, etc). Useful in a variety of control and sensing applications. Programmed via serial port (use our new Windows interface, terminal emulator or batch files). Serial cable can be up to 35m long. Includes plastic case 130 x 100 x 30mm. Power: 12VDC/500mA.
Kit Order Code: 3108KT – **£54.95**
Assembled Order Code: AS3108 – **£64.95**

Infra-red RC 12-Channel Relay Board



Control 12 on-board relays with included infra-red remote control unit. Toggle or momentary. 15m+ range. 112 x 122mm.
Supply: 12VDC/0·5A.
Kit Order Code: 3142KT – **£41.95**
Assembled Order Code: AS3142 – **£59.95**

PC Data Acquisition & Control Unit



Monitor and log a mixture of analogue and digital inputs and control external devices via the analogue and digital outputs. Monitor pressure, temperature, light intensity, weight, switch state, movement, relays, etc. with the apropriate sensors (not supplied). Data can be processed, stored and the results used to control devices such as motors, sirens, relays, servo motors (up to 11) and two stepper motors.

Features

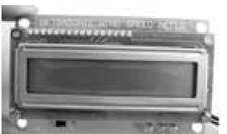
- 11 Analogue Inputs – 0·5V, 10 bit (5mV/step)
- 16 Digital Inputs – 20V max. Protection 1K in series, 5·1V Zener
- 1 Analogue Output – 0-2·5V or 0-10V. 8 bit (20mV/step)
- 8 Digital Outputs – Open collector, 500mA, 33V max
- Custom box (140 x 110 x 35mm) with printed front & rear panels
- Windows software utilities (3·1 to XP) and programming examples
- Supply: 12V DC (Order Code PSU203)

Kit Order Code: 3093KT – **£69.95**
Assembled Order Code: AS3093 – **£99.95**

Cool New Kits This Winter!

Here are a few of the most recent kits added to our range. See website or join our email Newsletter for all the latest news.

NEW! EPE Ultrasonic Wind Speed Meter



Solid-state design wind speed meter (anemometer) that uses ultrasonic techniques and has no moving parts and does not need calibrating. It is intended for sports-type activities, such as track events, sailing, hang-gliding, kites and model aircraft flying, to name but a few. It can even be used to monitor conditions in your garden. The probe is pointed in the direction from which the wind is blowing and the speed is displayed on an LCD display.

Specifications

- Units of display: metres per second, feet per second, kilometres per hour and miles per hour
- Resolution: Nearest tenth of a metre
- Range: Zero to 50mph approx.

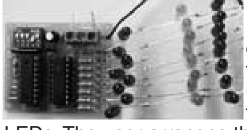
Based on the project published in Everyday Practical Electronics, Jan 2003. We have made a few minor design changes (see web site for full details). Power: 9VDC (PP3 battery or Order Code PSU203).
Main PCB: 50 x 83mm.
Kit Order Code: 3168KT – **£34.95**

NEW! Audio DTMF Decoder and Display



Detects DTMF tones via an on-board electret microphone or direct from the phone lines through an audio transformer. The numbers are displayed on a 16-character, single line display as they are received. Up to 32 numbers can be displayed by scrolling the display left and right. There is also a serial output for sending the detected tones to a PC via the serial port. The unit will not detect numbers dialled using pulse dialling. Circuit is microcontroller based.
Supply: 9-12V DC (Order Code PSU203).
Main PCB: 55 x 95mm.
Kit Order Code: 3153KT – **£17.95**
Assembled Order Code: AS3153 – **£29.95**

NEW! EPE PIC Controlled LED Flasher



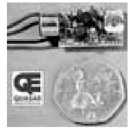
This versatile PIC-based LED or filament bulb flasher can be used to flash from 1 to 160 LEDs. The user arranges the LEDs in any pattern they wish. The kit comes with 8 superbright red LEDs and 8 green LEDs. Based on the Versatile PIC Flasher by Steve Challinor, *EPE* Magazine Dec '02. See website for full details. Board Supply: 9-12V DC. LED supply: 9-45V DC (depending on number of LED used). PCB: 43 x 54mm.
Kit Order Code: 3169KT – **£10.95**

Most items are available in kit form (KT suffix) or assembled and ready for use (AS prefix)

FM Bugs & Transmitters

Our extensive range goes from discreet surveillance bugs to powerful FM broadcast transmitters. Here are a few examples. All can be received on a standard FM radio and have adjustable transmitting frequency.

MMTX' Micro-Miniature 9V FM Room Bug



Our best selling bug! Good performance. Just 25 x 15mm. Sold to detective agencies worldwide. Small enough to hide just about anywhere. Operates at the 'less busy' top end of the commercial FM waveband and also up into the more private Air band.
Range: 500m. Supply: PP3 battery.
Kit Order Code: 3051KT – **£8.95**
Assembled Order Code: AS3051 – **£14.95**

HPTX' High Power FM Room Bug



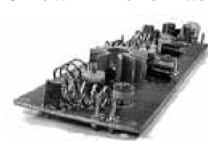
Our most powerful room bug. Very Impressive performance. Clear and stable output signal thanks to the extra circuitry employed.
Range: 1000m @ 9V. Supply: 6-12V DC (9V PP3 battery clip suppied). 70 x 15mm.
Kit Order Code: 3032KT – **£9.95**
Assembled Order Code: AS3032 – **£17.95**

MTTX' Miniature Telephone Transmitter



Attach anywhere along phone line. Tune a radio into the signal and hear exactly what both parties are saying. Transmits only when phone is used. Clear, stable signal. Powered from phone line so completely maintenance free once installed. Requires no aerial wire – uses phone line as antenna. Suitable for any phone system worldwide. Range: 300m. 20 x 45mm.
Kit Order Code: 3016KT – **£7.95**
Assembled Order Code: AS3016 – **£13.95**

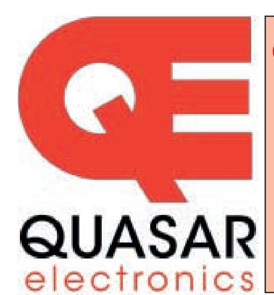
3 Watt FM Transmitter



Small, powerful FM transmitter. Audio preamp stage and three RF stages deliver 3 watts of RF power. Can be used with the electret microphone supplied or any line level audio source (e.g. CD or tape OUT, mixer, sound card, etc). Aerial can be an open dipole or Ground Plane. Ideal project for the novice wishing to get started in the fascinating world of FM broadcasting. 45 x 145mm.
Kit Order Code: 1028KT – **£22.95**
Assembled Order Code: AS1028 – **£34.95**

25 Watt FM Transmitter

Four transistor based stages with a Philips BLY89 (or equivalent) in the final stage. Delivers a mighty 25 Watts of RF power. Accepts any line level audio source (input sensitivity is adjustable). Antenna can be an open dipole, ground plane, 5/8, J, or YAGI configuration. Supply 12-14V DC, 5A. Supplied fully assembled and aligned – just connect the aerial, power and audio input. 70 x 220mm.
Order Code: 1031M – **£124.95**



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Order Code EPL200 – **£47.95**
30, 130-300 and 500-in-1 project labs also available – see website for details.

Number 1 for Kits!

With over 300 projects in our range we are the UK's number 1 electronic kit specialist. Here are a few other kits from our range.

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3106KT – 50W Mono Hi-fi Amplifier £19.95
3143KT – 10W Stereo Amplifier £9.95
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NEW

EPE PIC PROJECTS VOLUME 1 MINI CD-ROM



A plethora of 20 "hand-PICked" PIC Projects from selected past issues of *EPE*

Together with the PIC programming software for each project plus bonus articles

The projects are:

PIC-Based Ultrasonic Tape Measure
You've got it taped if you PIC this ultrasonic distance measuring calculator

EPE Mind PICkler
Want seven ways to relax? Try our PIC-controlled mind machine!

PIC MIDI Sustain Pedal
Add sustain and glissando to your MIDI line-up with this inexpensive PIC-controlled effects unit

PIC-based MIDI Handbells
Ring out thy bells with merry tolling – plus a MIDI PIC-up, of course!

EPE Mood PICker
Oh for a good night's sleep! Insomniacs rejoice – your wakeful nights could soon be over with this mini-micro under the pillow!

PIC Micro-Probe
A hardware tool to help debug your PIC software

PIC Video Cleaner
Improving video viewing on poorly maintained TVs and VCRs

PIC Graphics LCD Scope
A PIC and graphics LCD signal monitor for your workshop

PIC to Printer Interface
How to use dot-matrix printers as data loggers with PIC microcontrollers

PIC Polywhatsit
A novel compendium of musical effects to delight the creative musician

PIC Magick Musick
Conjure music from thin air at the mere untouching gesture of a fingertip

PIC Mini-Enigma
Share encrypted messages with your friends — true spymaster entertainment

PIC Virus Zapper
Can disease be cured electronically? Investigate this controversial subject for yourself

PIC Controlled Intruder Alarm
A sophisticated multi-zone intruder detection system that offers a variety of monitoring facilities

PIC Big-Digit Display
Control the giant ex-British Rail platform clock 7-segment digits that are now available on the surplus market

PIC Freezer Alarm
How to prevent your food from defrosting unexpectedly

PIC World Clock
Graphically displays world map, calendar, clock and global time-zone data

PICAXE Projects
A 3-part series using PICAXE devices – PIC microcontrollers that do not need specialist knowledge or programming equipment

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NOTE: The PDF files on this CD-ROM are suitable to use on any PC with a CD-ROM drive. They require Adobe Acrobat Reader.

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- Full kit with ALL hardware and electronics
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- Seeks light, beeps, avoids obstacles
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- Uses 8-pin PIC
- ALSO KIT 911 – As 910 *PLUS* programmable from PC serial port – leads and software CD provided



KIT 910 £16.99   KIT 911 £24.99

EPE TEACH-IN 2004

THE LATEST SERIES – STARTED NOV '03
ALL PARTS INCLUDING PROTOTYPE BREADBOARD AND WIRE – AS LISTED ON p752 NOV. ISSUE (EXCL MISC.)
"A BRILLIANT NEW ELECTRONICS COURSE"

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ADDITIONAL PARTS – AS LISTED UNDER MISCELLANEOUS – BUT LESS RADIO MODULES, SOLENOID LOCK AND MOTOR/GEARBOX.

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PIC 16F84 MAINS POWER 4-CHANNEL CONTROLLER & LIGHT CHASER

- ZERO VOLT SWITCHING
- OPTO ISOLATED 5 Amp
- 12 KEYPAD CONTROL
- HARD-FIRED TRIACS
- WITH SOURCE CODE
- SPEED & DIMMING POT.
- EASILY PROGRAMMED

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EPE PIC Tutorial V2

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INCLUDES 1-PIC16F84 WITH DEMO PROGRAM SOFTWARE DISK, PCB, INSTRUCTIONS AND 16-CHARACTER 2-LINE **LCD DISPLAY**

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Power Supply £3.99

FULL PROGRAM SOURCE CODE SUPPLIED – DEVELOP YOUR OWN APPLICATION!

Another super PIC project from Magenta. Supplied with PCB, industry standard 2-LINE × 16-character display, data, all components, and software to include in your own programs. Ideal development base for meters, terminals, calculators, counters, timers – Just waiting for your application!

PIC TUTOR 1

MARCH - APRIL - MAY '98 EPE SERIES 16F84

PIC TUTOR BOARD KIT

Includes: PIC16F84 Chip, TOP Quality PCB printed with Component Layout and all components* (*not ZIF Socket or Displays). Included with the Magenta Kit is a disk with Test and Demonstration routines.

KIT 870 .... £27.95, Built & Tested £42.95

Optional: **Power Supply – £3.99, ZIF Socket – £9.99**
LCD Display .... £7.99   LED Display £6.99
Reprints Mar/Apr/May 98 – **£3.00 set 3**

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NEW!

As featured in Aug./Sept. '99 *EPE*. Full kit with Magenta redesigned PCB – LCD fits directly on board. Use as Data Logger *or* as a test bed for many other 16F877 projects. Kit includes programmed chip, 8 EEPROMs, PCB, case and all components.

KIT 877 £49.95 inc. 8 × 256K EEPROMS

SUPER PIC PROGRAMMER

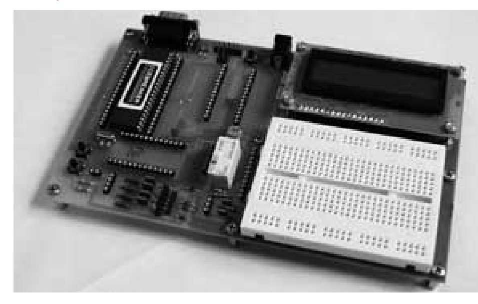
- READS, PROGRAMS, AND VERIFIES
- WINDOWS™ SOFTWARE
- PIC16C AND 16F – 6X, 7X, AND 8X
- USES ANY PC PARALLEL PORT
- USES STANDARD MICROCHIP
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PIC Real Time In-Circuit Emulator

- Icebreaker uses PIC16F877 in circuit debugger
- Links to Standard PC **Serial** Port (lead supplied)
- Windows™ (95+) Software included
- Works with MPASM and MPLAB Microchip software
- 16 x 2 L.C.D., Breadboard, Relay, I/O devices and patch leads supplied

As featured in March '00 *EPE*. Ideal for beginners AND advanced users.
Programs can be written, assembled, downloaded into the microcontroller and run at full speed (up to 20MHz), or one step at a time.
Full emulation means that all I/O ports respond exactly and immediately, reading and driving external hardware.
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KIT 900 . . . £34.99

POWER SUPPLY **£3.99**   STEPPING MOTOR 100 STEP **£9.99**

PIC STEPPING MOTOR DRIVER

INCLUDES PCB, PIC16F84 WITH DEMO PROGRAM, SOFTWARE DISC, INSTRUCTIONS AND MOTOR.

Kit 863 £18.99

FULL SOURCE CODE SUPPLIED ALSO USE FOR DRIVING OTHER POWER DEVICES e.g. SOLENOIDS

Another Magenta PIC project. Drives any 4-phase unipolar motor – up to 24V and 1A. Kit includes all components and 48 step motor. Chip is pre-programmed with demo software, then write your own, and re-program the same chip! Circuit accepts inputs from switches etc and drives motor in response. Also runs standard demo sequence from memory.

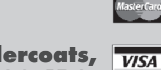


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See Next/Last Months Ad. for ELECTRONIC COMPONENTS

PCB Production - Processing Equipment
We carry a large range of the photographic & chemical processing equipment for PCB production, a full list with full technical specifications is available in our catalogue or visit our web site.

UV Exposure units
2 x 8W Tubes, 6 min timer
229 x 159mm working area
Model 332-002 £88.78
4 x 15W Tubes, 7½ min timer
330 x 260mm working area
Model 332-004 £194.51

Chemical Processing
Low cost plastic tray £2.14
Process tanks feature electrically operated pumps and/or heaters with thermostat control, suitable for boards upto 320 x 260mm.
Universal Tank with heater
Model 333-007 £161.60
Bubble etch Tank with heater & bubble pump.
Model 333-004 £198.50



Any of these items, carriage £5.50

PCB Production - Laminates

Copper clad - paper
Single sided low cost paper composite board
100 × 160mm Board £0.44
100 × 220mm Board £0.62
160 x 233mm Board £1.02
220 x 233mm Board £1.40
8″ x 12″ Board £1.70

Copper clad - glass fibre
Single & Double 1.6mm 305g/m²
100 × 160mm Single £0.85
100 × 220mm Single £1.18
160 x 233mm Single £2.29
220 x 233mm Single £2.88
8″ x 12″ Single £3.44
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100 × 220mm Double £1.25
160 x 233mm Double £2.30
220 x 233mm Double £2.90
8″ x 12″ Double £3.50

Photoresist Coated
1.6mm 35 micron Pre-coated with a high quality photo-resist layer. Available in low cost paper composite or Glass fibre, Single & Double sided. Other sizes also available.

Size	Paper Single	Paper Double	Glass Fibre Single	Glass Fibre Double
4 × 6″	£1.47	£1.82	£1.89	£2.17
6 × 12″	£4.20	£5.04	£5.60	£6.23
9 x 12″	£6.30	£7.70	£8.40	£9.38
10 x 12″	£8.19	£10.01	£10.78	£11.83
12 x 12″	£8.26	£10.08	£10.99	£12.25
100 × 160mm			£2.38	£2.66
203 × 114mm			£3.01	£3.43
220 × 100mm			£3.08	£3.71
233 x 160mm			£4.83	£5.32
233 x 220mm			£6.83	£7.70

PCB Production - Development

0.1″ Copper Stripboard

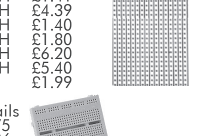
Size	Tracks/Holes	
25 x 64mm	9T / 25H	£0.24
64 x 95mm	24T / 37H	£0.87
95 × 127mm	36T / 50H	£1.41
95 × 432mm	36T / 170H	£4.39
100 × 100mm	39T / 38H	£1.40
100 × 160mm	39T / 63H	£1.80
100 × 500mm	39T / 199H	£6.20
119 × 455mm	46T / 179H	£5.40

Stripboard track cutter £1.99

Solderless Breadboard

Tie Points	& Size	Power Rails	
390	81 x 60mm	2	£2.75
840	175 x 67mm	2	£4.86
740	175 x 55mm	1	£4.03
640	175 x 42mm	0	£3.08

Many other sizes available, also jump wires & matrix board.



PCB Production - Tools

Drill Bits
HSS parallel shank bits available in sizes from 0.3mm to 2.0mm
0.3-0.95mm in 0.05mm steps £0.60ea £4.00/10
1.0-2.0mm in 0.1mm steps £0.40ea £3.60/10
HSS Reduced shank (2.35mm) bit available in sizes from 0.6mm to 1.7mm in 0.1mm steps £0.84ea £7.60/10
Reground Tngsten carbide reduced shank (3.2mm) available in sizes from 0.6 to 1.6mm in 0.1mm steps £1.90

Drilling Machines
Expo reliant 12V drill, 3.8mm capacity, 8400rpm £12.78

Minicraft MX1 230V, 8000 - 21000rpm with chuck & collet.
Model EPE270-390
Normal price £48.51



** **SPECIAL OFFER PRICE £31.02** **

PCB Production - Chemicals

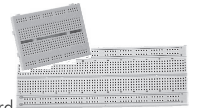
100ml	Aerosol Photoresist spray, covers 2m²	£4.2
50g	Powder developer, makes 1lt	£1.0
500g	Powder developer, makes 10lt	£7.0
250g	Ferric Chloride Pellets, makes 500ml	£1.6
500g	Ferric Chloride Pellets, makes 1lt	£3.0
2.5kg	Ferric Chloride Pellets, makes 5lt	£9.8
1.1kg	Clear Fine etch crystals, makes 5lt	£17.5
90g	Tin Plating Powder, makes 1lt	£11.5
200ml	Aerosol Flux spray	£3.4
110ml	Aerosol PCB Laquer spray	£3.6

PCB Production - Drafting Materials

A4 Artwork Film (per 10 sheets)
Clear Manual Film £1.25
Clear Laser Film £1.75
White HQ Laser Film £4.62

Etch Resist Pens
"Dalo" Pen £2.70
"Staedtler" Fine Pen £0.88

Etch Resist Transfers
Seno mixed DIL pads £2.24
Seno mixed Rnd pads £2.24
Alfac mixed pads £1.84
Alfac mixed lines £1.84
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We carry the full range of Seno & Alfac PCB transfers, see our catalogue for full details.



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200ml Switch Cleaner £1.96
200ml Freezer £3.97
400ml Foam Cleanser £2.13
400ml Cleaner / lubricant £2.79
75ml Vide Head Cleaner £1.94
200ml Aero Klene £2.85
200ml Aero Duster £4.66
250ml Cold Clean £3.14
200ml Label remover £3.52
400ml Isopropyl alcohol £3.36

Tubes
25g Heatsink Compound £2.60
50g Silicone grease £2.50



Magnifying Desk Lamp
A high quality scratch resistant magnifying glass fitted to a balanced swivel arm and desk mount. An integral flourescent tube provides illumination.
Magnification: 3x Lens: 120mmØ
Tube: 22W Daylight simulation.

Model: 028-205 £28.80

Soldering Irons
We carry in stock a wide range of soldering iron and soldering accessories. Irons from 12 to 100 Watts.
15W 240V Low cost £2.80
20W 240V Basic £3.74
25W 240V Ceramic £14.05
30W 240V Basic £4.68

Desolder Pumps
Basic 165 x 18mmØ £2.85
Antistatic 195mm £3.92
Antex Mini 198mm £6.02
Antex Pro 210mm £10.26

NEW CATALOGUE OUT NOW

available from **www.esr.co.uk**

Tools - Cutters & Strippers
We carry a wide range of specialist tools for the electronics industry including:

Side Cutters
130mm Low cost £1.99
115mm Draper £2.38
115mm Box Jointed £4.26
145mm Long reach £3.40

Wire Strippers
130mm Low cost £2.30
150mm Draper 5mmØ £5.86

Soldering Station
A 48W adjustable temperature soldering station with a rotary dial, LED Temperature metering, on-off switch, iron holder and tip cleaning sponge. This station features accurate heat sensing for instant compensation & stable temperatures. Adjustable temperature range of 150 - 420°C, Low voltage iron with Silicone cable.
Supply: 240V, Iron: 24V 48W

Model 167-540 £44.50

Educational Kits
These kits are an ideal way to start you interset in electronics. They freature re-useable components which are attached via springs & wires and easy step by step guides to make a range of exciting projects. The 300-in-1 featurs a breadboard for more complex circuits.



30-in-1 £12.80
50-in-1 £16.80
130-in-1 £32.00
300-in-1 £55.20

Tools - Ratchet Crimping Pliers
High quality ratchet crimping pliers for various termina... including Automotive, Data, Power and Data connection...
Red / Blue / Yellow £15.80
BNC /TNC RF series £15.19
RJ11/12 Data Series £22.32
RJ45 Data Series £20.43
RJ11/12 & 45 Series £12.64

CK® Tools Crimp Pliers
Green/Red/Blue £24.38
Red/Blue/Yellow £21.83
0.24-2.5mm² crimps £24.35
0.5-6.0mm² crimps £24.77
Non insulated crimps £24.38



Soldering Station
A 48W adjustable temperature soldering station with a rotary dial, Digital Temperature Indication, on-off switch, iron holder and tip cleaning sponge. This station features accurate heat sensing for instant compensation & stable temperatures. Adjustable temperature range of 150 - 480°C, Low voltage iron with Silicone cable.
Supply: 240V, Iron: 24V 48W

Model 167-570 £58.75



Cable - Ribbon
7/0.127mm Grey ribbon cable on a 0.05" 1.27mm pitch with a red identifying stripe. Supplied by 305mm (1ft) o... on full 30.5m (100ft) reels.

Size	per 305mm	per Reel
10 Way	£0.10	£5.36
14 Way	£0.14	£7.50
16 Way	£0.16	£8.58
20 Way	£0.20	£10.72
26 Way	£0.26	£13.94
34 Way	£0.34	£18.22
40 Way	£0.40	£21.44
50 Way	£0.50	£26.80
60 Way	£0.64	£33.92

IDC Crimp tool £11.80

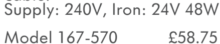


Panel Meters
High quality analogue panel meters, class 2, zero point correction, mirror scale and prewired for panel illumination. Meter size 46 x 60mm, Cutout size: 38mmØ.

Range	Int Ω
0-50 A	6k5
0-100 A	1k0
0-500 A	430Ω
0-1mA	200Ω
0-10mA	2Ω6
0-50mA	1Ω2
0-100mA	0Ω65
0-500mA	0Ω12
0-1A	60mΩ
0-3A	20mΩ
0-5A	12mΩ
0-15A	4mΩ
0-10V	10k
0-15V	15k
0-30V	30k
±50 A	1k9

All meters £5.89 each
6V Lamps £1.23 /pair

CCTV - Complete Systems
We carry the full range of *Micromark* Black & White and Colour CCTV systems for the home or office.
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Black & White Systems from £22.97

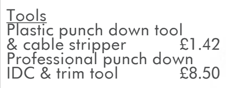
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305m Box, conforms to CAT5E 100MHz standard, ETA verified TIA/EIA 568-B.2

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Patch & Cross-over leads from £0.50, Full range of out... modules/keystone outlets, switches & accessories.



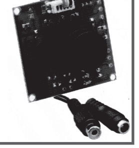
CCTV - Black & White Module
A miniature CMOS camera module with a 3.6mm F2 Lens, video output & power via connectors provided.

Specs (660-800)
Power: 12Vdc 50mA
Video System: CCIR
Pixels: 352 x 288
Min Illumination: 0.5Lux
Video Output: 1 Vpp, 75Ω
Dims: 35 x 35 x 28mm 20g **£17.93**



CCTV - Colour Module
A miniature colour CMOS camera module with a 3.6mm F1.2 Lens, video output & power via connectors provided.

Specs (660-842)
Power: 12Vdc 150mA
Video System: PAL
Pixels: 628 x 582
Min Illumination: 3Lux
Video Output: 1 Vpp, 75Ω
Dims: 28 x 28 x 28mm 20g **£36.33**





VOL. 33 No. 4 **APRIL 2004**

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A FINE DAY

It's a lovely bright February morning, with frost on the ground and not a cloud in the sky. My desk is filling up with about 30 emails, a few invoices, a large "Employer's Pack 2004" from the Inland Revenue (which thankfully I can pass straight on to our Business Manager, David Leaver), three *IU* submissions and a couple of proposed constructional projects – one involving blue tits (the birds); it keeps life interesting!

As usual it's "pass for press" this week so I'm under pressure to write an *Editorial* and it occurred to me that it might be interesting to tell you what exactly we do. As I write, Dave is finishing off laying out all the articles – deciding what we have room for this month, where each article will go in the magazine, fitting in all the adverts and making sure the colour ones fall on colour pages. Pete is changing the finished pages from Quark Xpress – the software we use to produce the pages – into PDFs to send on CD-ROM to our printer, Apple Web Offset in Warrington. He is also waiting for the last few corrected diagrams to come from our two freelance artists Andy Flind and Matt Pulzer – the drawings are produced in Corel Draw and come in on CD-ROM or via email, depending on the last minute urgency, and for the heading artwork and covers to come from Colette Brownrigg, who produces them for us.

John is making the final checks on the page proofs, writing bits for the *Carryover* (the page that tells you what's coming next month) and also checking the final version of the *Electronics Service Manual* CD-ROM, now that we have finally been able to change that over to CD-ROM rather than the printed Manual.

While all this is going on, Marilyn is updating the subscription database with new orders, renewals and changes of address, plus sending out back issues and p.c.b.s, banking the payments and taking phone orders. Pauline is dealing with all the *Direct Book Service* and CD-ROM orders, plus looking after the *Radio Bygones* subscriptions and sending emails to the mailing house with labels for *EPE* and *RB* subscriptions ready for the issues to be posted out, ordering books, CDs and PIC Development Boards, banking the payments, answering email queries and contacting readers if there are problems with payments etc. Whilst worrying that we simply cannot get our hands on enough *Amateur Scientist* CD-ROMs to fulfill the massive demand created by Max's review of it in last month's issue (a problem that should be solved by the time you read this).

In the next office Fay is downloading and sorting all the Internet orders, updating the Online Shop, answering readers' queries whilst also producing a booklet for another publication, keeping control of subscriptions for three Australian magazines we look after and fielding calls from sales people, companies wanting to reduce our rates and phone bills and dealing with all sorts of other queries and requests that come in by phone, fax, email and letter.

Back at his home, David Leaver is dealing with our accountants who are producing the figures for the company's last financial year, whilst also keeping the "books", chasing up outstanding invoice payments, producing management accounts and generally keeping our finances in order. Oh yes, and dealing with PAYE and NIC etc. in line with that Employers' Pack that is going in his direction.

It's now 10.15 a.m., the sun is still shining (bonus!) and I really must pass this to Pete for typesetting so I can attack the piles of paper on my desk and make room for a mug of coffee. Oh yes, I also need to do the covers for the next issue of *Radio Bygones!*

Mike Kenward

AVAILABILITY

Copies of *EPE* are available on subscription anywhere in the world (see opposite), from all UK newsagents (distributed by COMAG) and from the following electronic component retailers: Omni Electronics and Yebo Electronics (S. Africa). *EPE* can also be purchased from retail magazine outlets around the world. An Internet on-line version can be purchased and downloaded for just $10.99US (approx £7) per year available from **www.epemag.com**



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We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply *must* be accompanied by a **stamped self-addressed envelope or a self-addressed envelope and international reply coupons.**

PROJECTS AND CIRCUITS

All reasonable precautions are taken to ensure that the advice and data given to readers is reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it.
A number of projects and circuits published in *EPE* employ voltages than can be lethal. **You should not build, test, modify or renovate any item of mains powered equipment unless you fully understand the safety aspects involved and you use an RCD adaptor.**

COMPONENT SUPPLIES

We do not supply electronic components or kits for building the projects featured, these can be supplied by advertisers (see *Shoptalk*). **We advise readers to check that all parts are still available before commencing any project in a back-dated issue.**

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We advise readers that certain items of radio transmitting and telephone equipment which may be advertised in our pages cannot be legally used in the UK. Readers should check the law before buying any transmitting or telephone equipment as a fine, confiscation of equipment and/or imprisonment can result from illegal use or ownership. The laws vary from country to country; readers should check local laws.

Constructional Project

LOFT LIGHT ALARM



BART TREPAK

A low-cost, energy saving, versatile "left-on" reminder

THE LOFT is by its very nature a place which the householder seldom visits as the dust, cobwebs and "creepy-crawlies" found there do not make it a very pleasant place to be in. It does, however, contain such essential items as the cold water tank and very often, with the limited space available in some homes, is used to store all kinds of things which are only required once in a while, such as Christmas decorations, suitcases for holidays etc.

This makes the occasional visit necessary and many householders install a light bulb or two to help them find their way around when checking the tank or locating their suitcase. Having completed their task, they are often in such a hurry to leave that they forget to switch the lights off behind them. This can mean that the lights can accidentally be left on for weeks or even months at a time, resulting in a huge waste of energy.

DELAYED ACTION

One solution to this problem would be to fit a time delay switch to turn the lights off automatically after a suitable period should the owner forget to do so – but what is a suitable period? Should there be a problem with the tank for example, the work might take a few hours to complete while finding a suitcase should take no more than a few minutes and it would obviously be inconvenient and even dangerous if the lights were to suddenly go off. So, another solution was required.

The simple Loft Light Alarm has therefore been designed to sound an alarm if the light has been left on for a prolonged period and so remind the owner to switch it off rather than doing so automatically. It uses a timer to sound an alarm 15 minutes (which can be altered if required) after the light has been switched on and, since it is extremely easy to install, the unit should find many uses around the home beyond that for which it was originally designed.

SENSOR

The easiest way to detect if the light is on is to monitor the supply voltage across it and use this to power the timer and alarm. This would make the unit independent of batteries but the disadvantage of having to make connections to the lamp was felt undesirable, especially as mains voltages would be involved.

In any case, the unit would (hopefully) spend most of its time in the stand-by state so that battery power should not be much of a problem. Controlling a battery timer by means of a phototransistor or light-dependent resistor was also considered but this too was rejected because the author's loft, in common with many others no doubt, has a skylight so that complete darkness when the light is off could not be guaranteed.

Although a circuit to discriminate between daylight and mains powered lighting could be designed, a much simpler solution has been adopted. This uses the a.c. field which exists around any cable connected to the mains to switch on two transistors which remove the reset signal from the timer when the light is switched on.

CIRCUIT DESCRIPTION

The full circuit diagram for the Loft Light Alarm is shown in Fig.1, together with a typical mains lighting installation. When the mains on/off switch (S1) is open and the light is off, the cable feeding the lamp will be disconnected from mains Live (Line) so that no electric field will exist around it. Transistors TR1 and TR2 will therefore remain off and their collector (c) voltage will be at the battery positive potential so that a logic high level will exist at the Reset terminal of timer IC1 at pin 12, preventing it from operating or sounding an alarm.

When the light is switched on, however, the electric field, eminating from the Live lead of the lamp cable and picked up by the

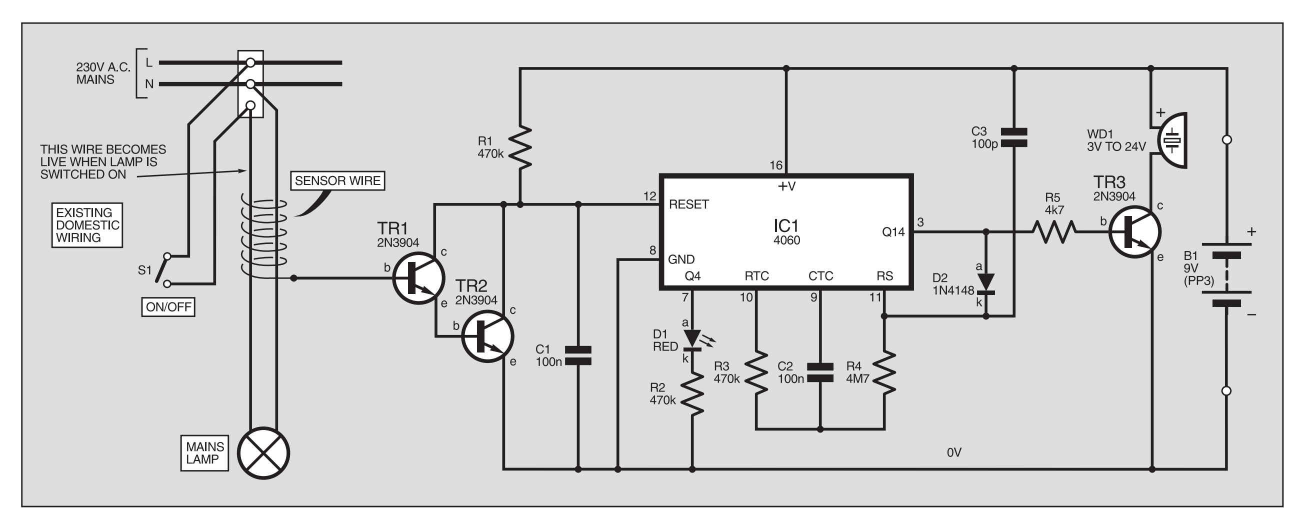


Fig.1. Complete circuit diagram for the Loft Light Alarm. The "circuit" to the left of the sensor wire is, of course, the existing house wiring.

sensor wire, will cause transistor TR1 to pass a small current which will form the base (b) current of TR2. The current gain of this compound transistor (connected in the Darlington pair configuration) is the product of the individual transistor gains and will be in excess of 10,000.

Even a minute current flowing in the sensor wire will thus cause the collector voltage to fall, taking the Reset pin of IC1 low. Because current will flow only when the base voltage of TR1 is positive, capacitor C1 is included to ensure that the reset pin remains low during the brief periods when the transistors turn off as the mains voltage goes through its negative half-cycle.

Note that the field exists only around the wire connected to the Live terminal of the mains as the Neutral is always at or near Earth potential. Since individual wires are seldom used and the lighting cable consists of all three L, N and E wires, it is important to wrap the "aerial" or sensor wire around the cable feeding the *lamp* fitting itself and *not* the cable running to the mains switch or that carrying the mains to other locations. This is because at least one of the wires in these cables will always be connected to the mains Live irrespective of whether the light is on or off.

It is also important to ensure that the mains on/off switch interrupts the Live connection to the lamp and not the Neutral. This is, of course, normal wiring practice even though electrically, the lighting circuit would still work normally if the Neutral were switched.

TIMER

Although an *RC* timer such as the popular 555 could just about be used to provide the 15 minute (900 second) delay specified, the timer here is based on the CMOS 4060 i.c. which contains an oscillator and a 14-stage binary divider and enables long delays to be achieved without resorting to extremely large resistor or capacitor values.

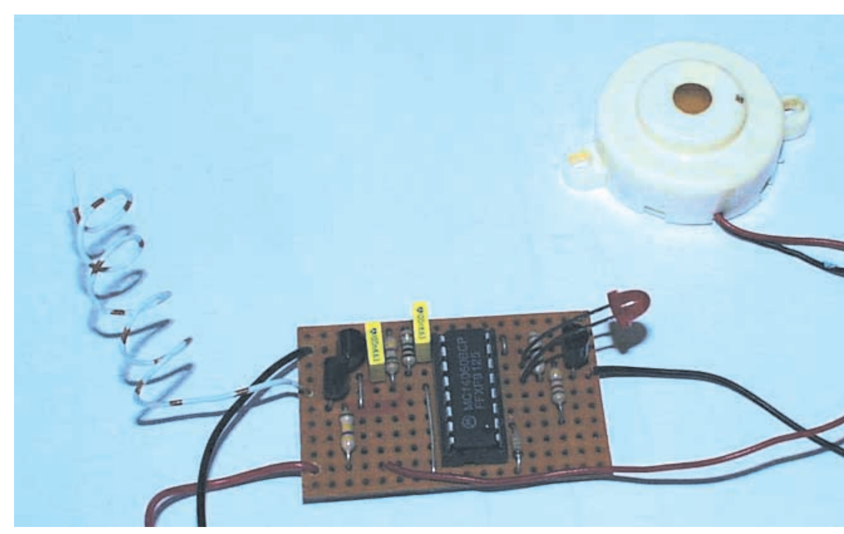
When the Reset pin 12 of IC1 goes low, the internal oscillator is enabled and oscillates at a frequency determined by the values of resistor R3 and capacitor C2. With the values given, this will be about 10Hz and a square wave with a period of around 0·1 seconds will therefore be available at pin 9 and will be divided by successive stages within the i.c.

Since all of the outputs start off in the low state following a reset, the output of stage 1 will go high after 0·1 seconds, the second stage after 0·2s, the next after 0·4s and so on doubling the time at each stage. The outputs of the first three stages are internal and are not available on any of the pins. Output Q4, which is the next stage available on pin 7, will go high after 1·6 seconds and then low after 1·6 seconds and continue switching on and off at this rate causing l.e.d. D1 to flash on and off indicating that the circuit is working.

Assuming that the timer is not reset in the meantime, output Q14 (pin 3), the final stage in the chain, will eventually go high after 8192 pulses which will be 819 seconds after the clock had been started. This will cause transistor TR3 to switch on sounding the alarm and pin 11 to go high via diode D2 inhibiting the clock. Since the clock oscillator is now stopped, output Q14 will remain high and the alarm will continue to sound until the counter is reset. No separate reset switch is required as this can be accomplished simply by switching the light off which will cause TR1/TR2 to switch off resetting the i.c.

The time delay is a little shorter than the 900 seconds specified but this can easily be corrected by increasing the value of resistor R3 slightly, although in this application it is not vitally important. Resistor R3 could be increased to 1M giving a delay of around 30 minutes and even longer delays may be achieved by increasing the value of C2 should this be required.

The circuit is powered by a 9V battery and in the stand-by mode, when the light is off, the current drain is extremely low consisting almost entirely of the current flowing through resistor R1. Current drain increases when the light is switched on as l.e.d. D1 begins to flash and reaches a maximum when the alarm switches on, but since the circuit will (hopefully) spend most of the time in the stand-by mode, the battery life should be long lasting.



The sensor wire and warning buzzer wired to the circuit board. The sensor wire is wrapped around the cable to the mains lamp – see Fig.1.

CONSTRUCTION

The Loft Light Alarm circuit is so simple that a special p.c.b. design was considered unnecessary and a suitable stripboard component layout, together with details of the underside breaks in the copper tracks, is shown in Fig.2. Construction should begin with cutting the copper tracks at the positions indicated, after which the components may be fitted as shown. The link wires and i.c. holder should be fitted first and the semiconductors last.

None of the components are critical although care should be taken to ensure that items such as transistors, diodes and, of course, the i.c. are fitted the correct way around. There are 14 breaks required in the tracks and three wire links which may be made from discarded component leads.

Virtually any high gain (100+) small signal *npn* transistor should be suitable and pin connections for the 2N3904 device specified are shown in Fig.3, together with a couple of (untried) alternatives. If substitutes are used, care should be taken to see that they are wired correctly.

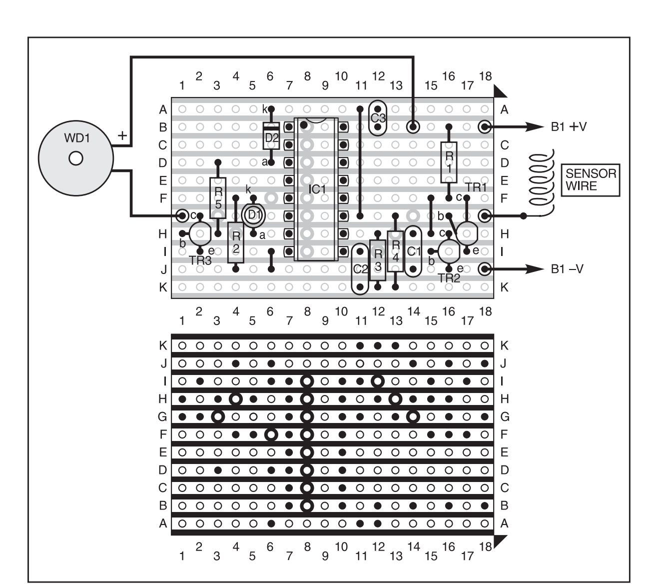


Fig.2. Stripboard topside component layout, wiring and details of the breaks required in the underside copper tracks.

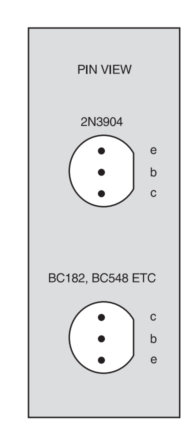
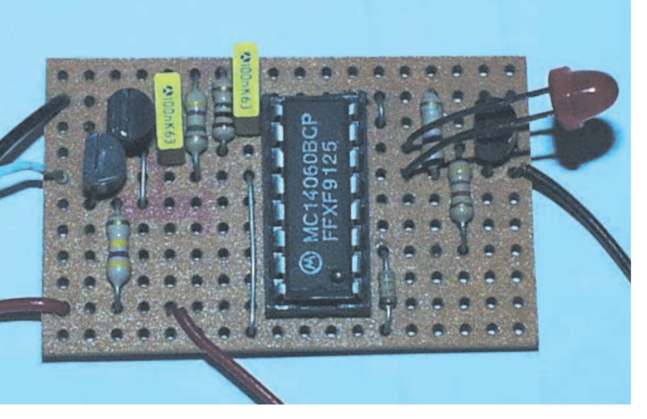


Fig.3. Pinout details for the 2N3904 transistor and alternative types.



Layout of components on the completed circuit board.

As mentioned earlier, IC1 is a CMOS device and should be handled carefully. As it is static sensitive, care should be taken to avoid touching the pins. The i.c. should be plugged into its socket at the end when all other components have been fitted and the board double-checked for any wiring errors.

Any sounder which operates on a 9V supply should be suitable as long as it can be heard from the loft and this will, of course, depend on individual circumstances. The best types would probably be piezo sounders, as these are fairly loud and consume relatively little power.

Be sure to purchase the type with an internal oscillator which requires only a connection to a d.c. supply to operate and not a sounder which consists of only the piezo element itself. These are normally available in 12V versions, although they almost invariably work with voltages of 6V or less. Since they contain internal circuitry, they must be connected the correct way around with the black (negative) wire going to TR3 collector.

ASSEMBLY

The battery is a 9V (PP3) type and should be connected to the board using a suitable battery connector. No on/off switch is required and one should not be fitted as this could defeat the object of the circuit.

The finished circuit board can be mounted in a small plastic box with dimensions adequate to accommodate the board and battery. The sounder can be mounted on the outside but if mounted inside, a suitable hole should be provided to enable the sound to be clearly heard.

The finished unit should be mounted near to the cable running to the lights and the details of this are left to the constructor, as this will depend on circumstances. The sensor or pick-up wire consists of a few centimetres of fairly stiff single-core hook-up wire or enamelled copper wire with a thickness of around 24 s.w.g or less (thicker). This should be wound a few times around the cable carrying the current to the lamp, making sure that the cable does not contain a wire which is connected to Live continuously.

In some circumstances, the whole box may be attached to the cable by this means, removing the need to make any other provision for fitting the device. Another solution is to use a metal bulldog clip replace the sensor wire and to attach the unit onto the lamp cable. In this case, the clip should be mounted on the box by means of a nut and bolt and connected to the base of transistor TR1 by means of a short wire. This will make the unit even easier to fit especially if it is to be used in other "portable" applications.

TESTING

Once construction is complete, the circuit can be tested by wrapping the "sensor wire" around the cable running to a table lamp (or attaching the unit to the cable by the bulldog clip if this is fitted) and switching the lamp on. The l.e.d. should flash at a rate of about once every two seconds or 30 times per minute indicating that the timer is running. It should also be possible to start and stop the timer by switching the lamp on and off by means of the switch fitted to the mains outlet socket. If the chosen socket does not have a switch, the plug should be removed instead.

Assuming that these tests are successful, there should be no need to test the unit for the full 15 minutes, especially as the time delay is not critical. Alternatively, a 47 kilohm resistor could be soldered across R3 to temporarily reduce the delay to a more convenient period.

ALTERNATIVE USES

As mentioned earlier, although designed for use with a loft light, the ease with which the unit can be installed makes it suitable for all kinds of applications where a mains powered appliance could be left on accidentally for prolonged periods. One application which comes to mind is the hot water tank which is often switched on to provide hot water for a shower when the central heating is switched off during the summer months and is then left on accidentally, wasting large amounts of power re-heating the water needlessly.

Another application closer to every hobbyist's heart is the soldering iron which, lacking a power on indicator, is often left on for extended periods, which not only poses a fire hazard if knocked over but can also be expensive in replacement bits.

Many other applications will no doubt present themselves and these may require different time delays which as described may be achieved by changing the values of R3 and/or C2. Note that this will also change the l.e.d. flash rate. If possible, capacitor C2 should be a non-polarised type although low value electrolytics with a high working voltage also seem to work without problems. If high values of capacitor are required however, it is probably best to use two electrolytic types connected in series opposition.

Shorter time delays are also available using the same oscillator components and one of the other outputs of the 4060 chip instead. Thus, with the values given but using output Q13 (pin 2) instead of Q14, the time delay will be halved to about 7·5 minutes. For the circuit to operate correctly however, all of the components connected to output Q14 (R5 and D2) should be connected to Q13 or whichever output is used. □

COMPONENTS

See **SHOP TALK** page

Resistors

R1, R3	470k (2 off)
R2	470Ω
R4	4M7
R5	4k7

All 0·25W 5% carbon film

Capacitors

C1, C2	100n polyester (2 off)
C3	100p ceramic

Semiconductors

D1	5mm red l.e.d.
D2	1N4148 signal diode
TR1 to TR3	2N3904 *npn* low power transistor or similar (3 off)
IC1	4060 CMOS 14-stage binary counter

Miscellaneous

WD1	3V to 24V d.c. piezoelectric buzzer
B1	9V battery (PP3 type), with clips

Stripboard, size 11 strips x 18 holes; plastic case, size and type to choice; 16-pin d.i.l. socket; length of single-core hook-up wire for mains pick-up lead (24 s.w.g. or thicker – see text); solder pins; solder etc.

Approx. Cost Guidance Only **£6** *excl. batt.*

News . . .

A roundup of the latest Everyday News from the world of electronics

ANTI-COPYING DEFEATED AGAIN

Should the music industry try reading the scientific literature? Barry Fox asks a pertinent question.

PRINCETON University in New Jersey has already debunked the myth that music on the Internet can be protected by inaudible watermarks. Princeton then told why all CD copy-protection was worthless. Now the author of the report, Alex Halderman, has blown the latest new system out of the water.

When hackers claimed they could defeat the Cactus copy-protection system, just by judiciously marking the disc with a felt-tip pen, record company BMG switched allegiance to the MediaMax system developed by US company Sunncomm and promoted it as having "passed all tests and met the toughest standards" and offering "an incredible level of security".

Princeton computer scientist Alex Halderman promptly bought a protected disc, Anthony Hamilton's *Comin' From Where I'm From*, and posted the news that it can be defeated in three ways: use the standard Windows options to disable the anti-copy "driver" software that the CD installs on a PC; use standard Windows options to disable the Windows Autorun feature, whereby a CD starts to play as soon as it is put into the PC; or, easiest of all, hold down the Shift Key on the PC Keyboard while the CD is put in, to suspend Autorun temporarily.

Sunncom first threatened Halderman with the fearsome Digital Millennium Copyright Act (browse **www.copyright.gov/legislation/dmca.pdf**), which carries heavy penalties for "circumvention", but has now backed off.

We'll Drink To That

LOUDSPEAKER research is not just hard grind. JVC has developed a loudspeaker that relies on booze as an essential part of the production process. The first models will go on sale this spring, as part of a desktop entertainment system.

Making hifi loudspeakers has always been a black art mix of science, trial and error. If stringed musical instruments and woodwinds sound good, a wooden loudspeaker cone should sound good too. The logic is inescapable. But wood dries and cracks.

JVC's research lab in Japan has now found the secret – marinade birch wood in *sake* to make it malleable before pressure moulding into a conical shape. A thin sheet of furniture wood is soaked in Japanese rice wine and then infused with thermosetting resin, moulded and heated to harden.

The first wooden speaker cones are appropriately mounted in cherry wood cabinets.

JVC says that cheap *sake* is all that's needed – using special mature blends makes no difference to the sound.

Barry Fox

LASER GRIPS

LASER Tools have introduced an ingeniously designed tool for holding wires in place while solder is prepared and applied. The tool provides convenient one-handed operation which allows the two wires to be positioned correctly before and during the soldering operation, forming a clean and effective join. It is expected to retail at around £15 (Laser part no 3497).

For more information contact Laser Tools Ltd., Dept EPE, Kineton Road, Southam, Warks CV47 0DR. Tel: 01926 815000.
Fax: 01926 815888.
Web: **www.lasertools.co.uk**.

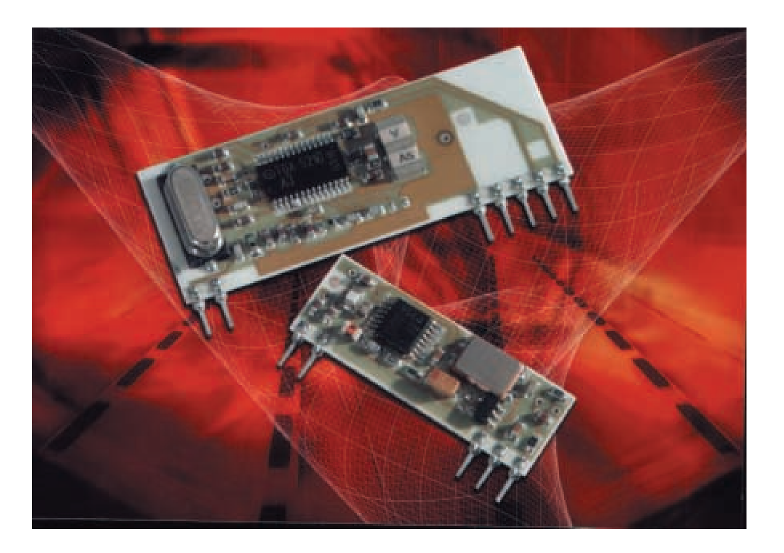
RED BINARY PALMS IT!

EPE reader Patrick Griffin tells us that he has developed some software for the Palm OS platform, and that it has been found to be exceedingly useful for electronics hobbyists.

The software is called Electrist and it presently contains calculators for 41 common electronics-related formulae and variations, with more to be added in due course. Patrick says that he knows similar software has been around for a while, but the Electrist interface is significantly different, with many much welcomed improvements.

For more information browse: **www.RedBinary.com**.

FM RADIO MODULES



THE new FM-RTFQ2 and FM-RRFQ2 transmitter and receiver modules from R.F. Solutions provide an economical high-performance FM radio data link in a wide range of applications. These include wireless security systems, remote sensing and data capture. Their small size and lower power consumption make them particularly useful in portable and battery powered applications.

The modules are available in 315MHz, 433MHz and 868MHz versions. The transmitter and receiver pair enable the implementation of wireless links with data rates up to 9·6Kbps at distances of up to 75 metres indoors and 250 metres in open ground.

For more information contact R.F. Solutions, Dept *EPE*, Unit 21, Cliffe Industrial Estate, South Street, Lewes, E.Sussex BN8 6JL. Tel: 01273 488000. Fax: 01273 480661. Email: sales@rfsolutions.co.uk. Web: **www.rfsolutions.co.uk**.

WEATHERPROOF GRAPHICS L.C.D.



LASCAR Electronics have introduced the SP5-GFX1 low cost weatherproof graphics liquid crystal display module. It utilises a high-contrast 128 x 64 pixel l.c.d. with vivid yellow/green l.e.d. backlighting. The l.c.d. is driven by the onboard Chip On Glass (COG), allowing the user to interface with it using serial communication. Connection to the module is via a simple 10-pin s.i.l. header.

Housed in a low-profile splash-proof bezel, the SP5-GFX1 can be fitted into any application with ease, "unlike many other graphic displays", say Lascar. Measuring only 36mm x 48mm, the module provides a high-resolution display in a compact package. It is priced at £21.95, with quantity discounts available.

For further information on the SP5-GFX1, and on Lascar's digital panel meters and data loggers, contact: Lascar Electronics Ltd, Dept *EPE*, Module House, Whiteparish, Salisbury, Wilts SP5 2SJ. Tel: 01794 884567. Fax: 01794 884616. Email: lascar@netcomuk.co.uk. Web: **www.lascarelectronics.com**.

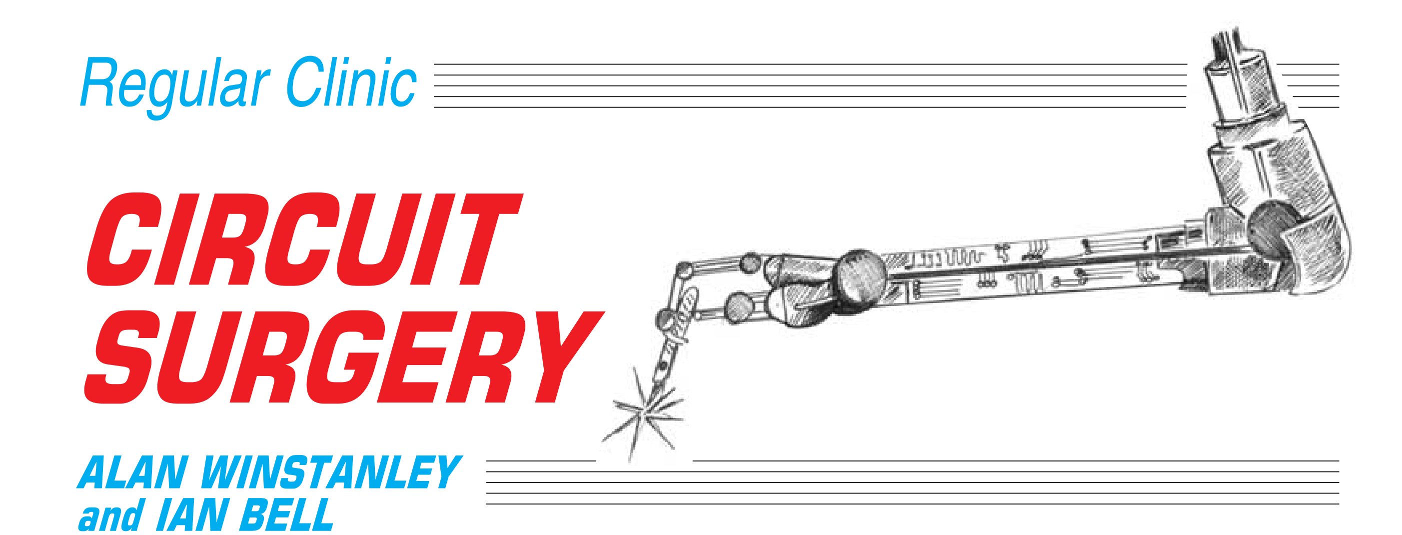
PIC Tutorially Awarded

MATRIX Multimedia have become renowned for the educational quality of their electronics and software orientated CDs and hardware. They tell us that they have recently won the 2004 Further Education BETT award for the product that "has made the most impressive impact on teaching, learning or institutional management in UK Further Education". Matrix's PICmicro microcontroller training system was judged to be the most impressive of the entries into this category.

Matrix say that this is the highest accolade that they can receive for their products in the UK and is great recognition for all the development effort they have put in over the last four years.

We feel that this achievement also reflects well on *EPE* as it was our Technical Editor John Becker who wrote the original *EPE PIC Tutorial* which he then modified on behalf of Matrix to become the renowned *PICtutor* product. John then further modified it to become the tutorial and demonstration software for the current *Assembly for PICmicro Microcontrollers V2.0*. Matrix describe this as a "complete solution for learning and teaching assembly code programming for PICmicro microcontrollers". This and other Matrix products are available from *EPE*, see elsewhere in this issue.

For more details: Matrix Multimedia Ltd, Dept *EPE*, The Factory, Emscote Street South, Halifax HX1 3AN. Tel: 01870 7001831. Fax: 01870 700 1832. Email: sales@matrixmultimedia.co.uk. Web: **www.matrixmultimedia.co.uk**.



This month our team of troubleshooters turn their attention to the use of inverters, describing the principles and perils of using lead-acid batteries to produce a mains voltage supply. Plus, we investigate a printed circuit board tracking problem.

Back to Inverters

RECENTLY ***Muhammed Abdallah Saif*** wrote to us from Ngora, Uganda concerning an inverter he wants to use to provide a mains level voltage from a 12V supply using a step-up transformer. The reader added that he had written to *Circuit Surgery* before with no apparent success, but we realised that we had actually discussed his earlier attempts in the August 2003 column, as a precursor to our introduction to PSPICE.

In his latest attempt, Mr Saif has opted to drive the step-up transformer using paralleled power MOSFETs instead of a bipolar driver, with their gate drives derived from a 556-based pulse generator. There was insufficient detail provided for us to be very specific about his latest design, but we hope that the following pointers will help.

The basic form of a typical power MOSFET based inverter is shown in Fig. 1. The two transistors are switched on alternately by the drive circuit. The arrangement of the transformer's split primary means that the two transistors switch current through the windings in opposite directions, giving us the positive and negative half cycles at the transformer's secondary. Paralleled MOSFETs can be used to increase the power handling capability of the circuit.

One problem we did identify from the reader's letter was that he was struggling to design a high-side driver after reading our guidelines in the Feb. '03 edition. The difference between high-side and low-side switching is shown in Fig.2 and Fig.3.

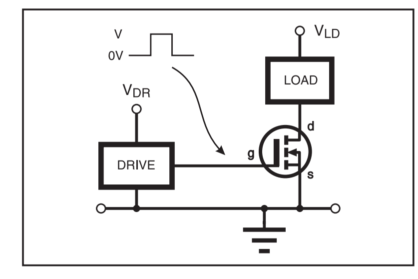


Fig.2. Basic low-side drive circuit.

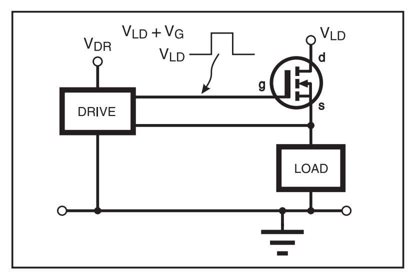


Fig.3. High-side drive circuit.

High side switching is difficult because it may require d.c. voltages slightly larger than the low voltage supply for the inverter in order to drive the MOSFET gates (e.g. 14V to 20V or more may be required with a 12V supply). These voltages have to be generated somehow. High-side switching is not essential in order to produce a working inverter: both transistors in Fig. 1 are low-side switches.

A recent inverter-based project is the *EPE Emergency Stand-By Light* in last month's issue. This is a 12V design capable of powering a small high-efficiency fluorescent bulb.

Inverter design needs careful consideration of the requirements. A number of important things should be established before you start, in particular the output voltage, power level and whether a.c. or d.c. output is required.

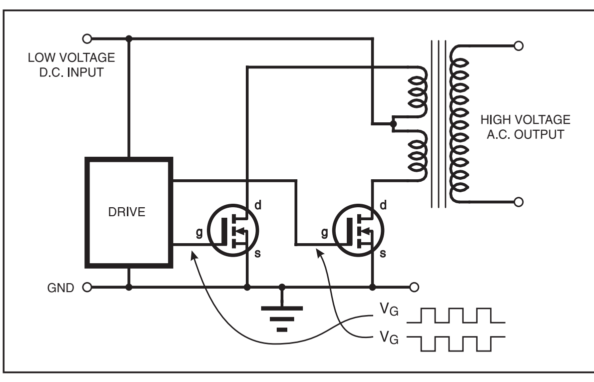


Fig.1. Inverter MOSFET-based circuit concept.

The inverter will, of course, use an a.c. signal in the transformer, but if a d.c. output voltage is required this internal a.c. signal does not have to be at any particular frequency. The use of high frequencies for d.c.-output inverters can provide better efficiency. If an a.c. output is required the frequency will probably be important.

Common Voltage

A common requirement for an inverter is to produce a mains-like voltage (usually around 110V or 230V r.m.s. at 50Hz or 60Hz) from a battery (often a 12V sealed lead-acid battery). The most straightforward circuits drive the transformer using switched transistors – typically power MOSFETs as we have already shown in Fig.1.

However this is a **square wave** signal, whereas the mains waveform is a **sinewave.** (If you want to know why it's a sinewave, refer to the mini series *From Pipelines to Pylons EPE* Aug. and Sept. '99). This fundamental difference cannot be overlooked as a lot of mains-powered equipment and appliances will not work, or will perform poorly, if supplied with a square wave signal.

A 230V a.c mains supply has a peak voltage of 325V; the 230V figure which is usually quoted is the r.m.s. (root mean square) value. (We discussed the maths behind r.m.s. voltages in *Circuit Surgery,* Sept. '99 – back issues are available.) Therefore a square wave of 230V peak (i.e. one switching between +230V and –230V) has the same r.m.s. voltage as the 325V peak, 230V r.m.s. standard mains signal. This means that an incandescent light, for example, would shine equally as brightly powered by either of these supplies.

Any equipment which is designed on the assumption that the mains will be a 325V peak *sinewave* may fail to work when

supplied with a 230V peak *square wave* simply because the full expected peak voltage is never reached. A sinewave is "pure" in that it only contains one frequency: however, a square wave contains frequencies at the harmonics of the basic repetition rate, going on up to potentially very high frequencies. This will produce noise in the circuitry of the equipment being powered, which may degrade performance.

Modified Sinewaves

The poor performance of square wave inverters for mains equipment use means that most commercial mains-output inverters that do not use sinewaves, employ a technique known as "modified sine". This is in fact a series of pulses with the same *peak* voltage as the mains sinewave (325V in our case).

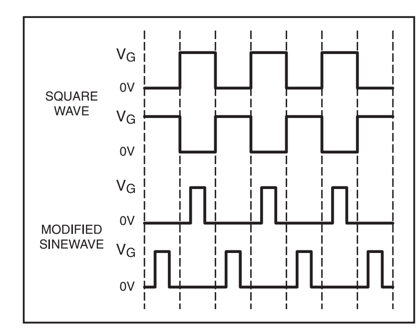


Fig.5. Drive waveforms for square wave and modified sinewave inverters. V_G is the gate voltage required to switch on the MOSFET. The traces show the two signals produced by the drive circuit in Fig.1.

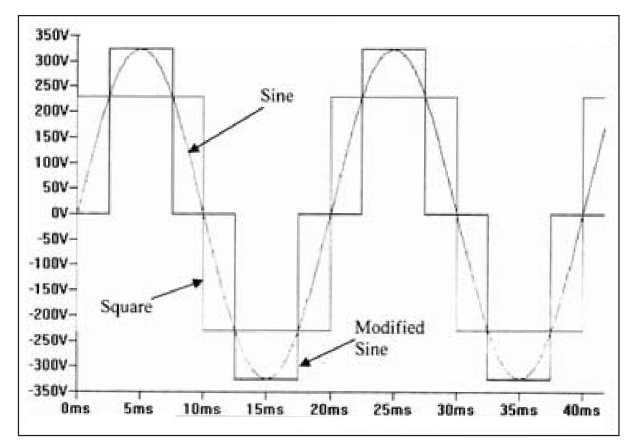


Fig.4. Idealised output waveforms for a 230V r.m.s. 50Hz mains inverter.

In order for this waveform to have the same r.m.s. value, the voltage has to be zero for 50% of the time. The three types of mains inverter waveform, square, sine, and modified sine, are all shown in Fig.4. Notice in particular the modified sine waveform and compare it against the other two.

The circuit shown in Fig.1 could be used to make a modified sine inverter: it is basically a matter of changing the drive signals. The required waveforms are shown in Fig.5. The waveforms for the modified sine drive circuit could be generated using a logic circuit.

However, even with a modified sine inverter you cannot run all types of appliance or equipment, possibly including tools with motor speed control, certain types of motor (or equipment containing them) and some sensitive electronic systems. The design of mains inverters should not be undertaken lightly, particularly if reasonable power levels are required. Producing high efficiency levels is much harder than simply getting a circuit to simply work: our *Emergency Standy-By Light* is unsuitable for incandescent lamps or other appliances, for example.

Poor efficiency can lead to a lot of heat being generated by an inverter. Apart from concentrating on getting the right output voltage, attention must be paid to safety features including fuses and cutouts for overload and over-temperature conditions. The correct heatsinks will be required for power devices and cooling fans as well (we described heatsink values in *Circuit Surgery*, Oct. '01 and cooling fan calculations in Nov. '03). Care must be taken with construction and testing as dangerous voltages will be present in the circuit.

Be Aware

Readers should be aware that the d.c. current requirement of an inverter soars at high power output levels. A deep-freezer operated by an inverter will make frozen mincemeat of any lead-acid battery: a typical generic imported inverter rated at 1,000W (such as the type regularly advertised in *EPE*) draws no less than 100 amps from the battery at full load, implying just half an hour's life from a typical car battery.

Lead-acid batteries intended for powering inverters must be kept fully charged and, as many motorists will know, they will only tolerate a limited number of complete charge/discharge cycles before failing, usually without warning. Many commercial inverters include a low battery-voltage dropout alarm or safety circuit, because a 12V battery is officially "flat" at about 10·5V or so. When used from a car cigar lighter outlet, though, then when a car battery is being charged (the engine is running), some manufacturers warn that 12V inverters *must not* be switched on, to avoid damage caused by the *increase* in d.c. battery voltage during charging.

Precautions that must be observed when handling lead acid batteries include avoiding creating sparks near the cells (risk of hydrogen explosion), and keeping metal bracelets, wristwatch straps and metal tools away from terminals to avoid short circuits, serious burns or spark hazards. *I.M.B.*

Cover Your Tracks

"I have problems desoldering parts from a printed circuit board without the copper foil track ends lifting away from the printed circuit board. I'm guessing that the foil trace ends are getting overheated. I doubt that I can remove the solder any quicker from the board.

Can I switch to a lower heating temperature? I use a desoldering iron at 30W. Would getting a soldering/desoldering station help? By controlling the temperature of the tip, I might be able to do a better job.

Next question: I have some circuit boards to repair. They have the foil track ends completely removed from the board. Is there an epoxy that I can use that can handle the temperature of a soldering iron? I could replace the foil traces with a wire. Can you recommend a better way to repair a circuit board with damaged traces?" Thanks from **Brian Soper** by email.

When you consider how little adhesive there is available to hold a tiny copper track or solder pad onto a p.c.b., it is not surprising that a delicate track can be lifted off by applying excess heat: a huge amount of heat, in comparison, is being focused onto that tiny area by the soldering iron bit. A temperature-controlled iron will help, such as the Antex brand (**www.antex.co.uk**) often advertised in *EPE* (though I would add that soldering iron tips do *not* glow red hot as the adverts might suggest!)

Apart from maintaining a reasonably stable operating temperature, it is imperative to perform soldering actions in the fastest time possible. Desoldering is trickier because it takes longer to keep the solder molten until the desoldering pump has removed it. Again, all you can do is to operate in the fastest time possible and try not to overheat the copper tracks so much that the adhesive fails, which allows the copper tracks to lift.

Silver Lining

If the track has lifted but is still intact, you can attempt to replace it again, and some success has been had using small drops of superglue as a repair. If the track has broken, then you have no choice but to attempt to repair with, e.g. a jumper wire soldered further up the track.

Consider using wire-wrapping wire on dense printed circuit boards. Solder one end then route it and tack it down in place with tiny drops of superglue applied with a pin. Another option is to try using silver-loaded lacquer, which is commonly used to repair damaged tracks. Brands include Chemtronics and Electrolube, and a pen-style dispenser was seen on sale in a Maplin shop.

In general, practice makes perfect, so you could try your hand at desoldering by obtaining a scrap computer motherboard or expansion card, and see how successfully you can remove some discrete parts without damaging the board. *A.R.W.*

Circuit Surgery will wherever possible offer advice or pointers to readers, but we cannot guarantee to do so, and the ease with which queries can be sent by email does nothing to help! It is not always possible to offer either quick "snap" or considered answers to every circuit, especially if it would be necessary to build or simulate the circuit, but we do read every letter, reply where we can and we publish a selection of your queries every month. You can send your emails to **alan@epemag.demon.co.uk**.

EXPERIMENTAL SEISMOGRAPH LOGGER



JOHN BECKER

Part One

Long-term data recording of the Earth's rock and roll events

THE term *Seismograph* comes from two Ancient Greek words, *seismos*, literally meaning earthquake, and *graphein*, to write.

Although seismographs are widely used to monitor naturally occurring earthquakes, they can be used to monitor *any* shaking of the earth, including movement caused by man's activities. Seismography is extensively used in geological exploration, for example, monitoring and recording the effects of explosions and the timed passage of their shock waves through the earth's crust.

On a less dramatic scale, seismographs can be used to monitor ground vibrations caused by trains, lorries and other vehicles. On a smaller scale still, even footsteps and sub-soil digging can be detected by seismological techniques (as immortalised in films and books about WW2).

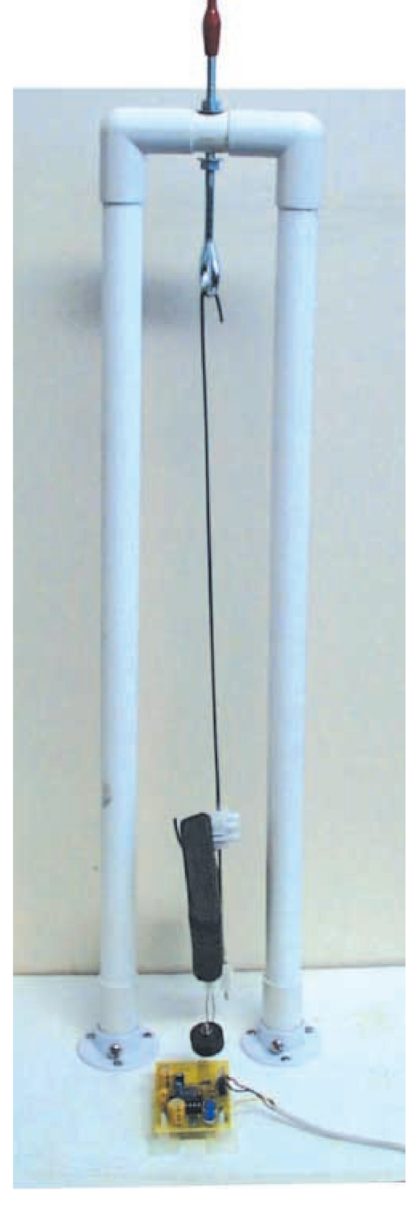
DUAL LOGGING MODES

The seismograph described here constantly records data from a sensor that responds to any displacement between it and a reference source. The associated electronics can be set to react even to minor earth shifts or vibrations.

It is worth noting that the electronics could also be used with an existing seismograph assembly if its sensor system outputs a d.c. voltage in the range of 0V to +5V. It might also be possible to add this design's sensor and electronics in their entirety to any pendulum-based seismograph.

Naturally, at the heart of the logger is a PIC microcontroller. Analogue signals from the sensor are amplified, limited by a low-pass filter, and fed to an analogue-to-digital input of the PIC. The PIC samples the data at 25Hz, constantly outputting it as a serial stream suitable for input to a PC and storage to its hard drive at a rate selected by the user.

It is believed that the PC software is compatible with Windows platforms 95, 98, ME, XP, NT and 2000, as long as they have a COM port. The software cannot be used with a USB port.



The PIC also stores the data to a bank of non-volatile serial memories (EEPROMs – electrically erasable programmable read-only memories), again at a user-set rate. The data can be downloaded to a PC as a complete block whenever desired, at intervals of hours, days, or even weeks.

At the PC, specially written software allows the data recorded by both techniques to be selectively displayed on screen. It is also in a format suited to further analysis by Microsoft Excel or similar spreadsheet and graphing display software.

INERTIA

Seismographs usually rely on the principle of inertia – the property of a body, proportional to its mass, which opposes a change in the motion of the body. In other words, probably like many of us after a good night out, objects don't want to move unless they are forced to!

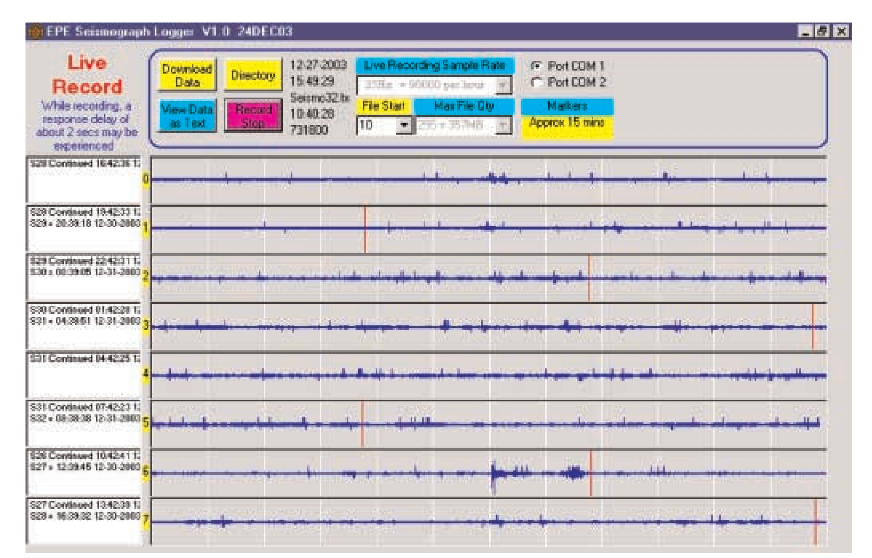
What this means in the context of seismography, is that if an object is suspended above the ground without contact with it, and the ground is caused to move, the object will stay where it is, and the separation between the ground and the object will change accordingly. Using a suitable sensor, this change in separation can be detected, and the amount of change quantified and recorded.

When considering the way in which this movement could be detected in a purely electronic manner, without mechanical assemblies, the author had originally thought that a motion sensor such as the ADXL105 accelerometer could be used. This was the device at the heart of Bill Mooney's *Pocket g-Meter* (July 2000).

The Analog Devices ADXL105 (and other similar types in its family) contains a tiny two-micrometre beam etched onto an integrated circuit such that it is supported at its corners by four flexible mounts. Positional changes of the beam in response to movement modify the capacitance of the assembly, and thus the frequency of an associated oscillator.

Regrettably, though, browsing the web in search of seismic detection techniques, it was found that this device was considered too insensitive to adequately detect ground movement waves whose source originated at far distances. One source commented that "someone on the Public Seismic Network mailing list (**www.seismicnet.com/maillist.html**) once calculated that it would take a local (under 100km) quake of magnitude five or larger before you would get a useful signal out of this type of sensor".

Consequently, ideas of using such a sensor were abandoned. It was obvious that a more "traditional" movement sensing technique had to be used. These techniques involve pendulum assemblies of various types. The simplest is a normal (Simple) pendulum, in which a weight is suspended from a long wire secured to a suitable wall-mounted fixing point (Fig.1).



Example of the author's PC screen displaying general earth movement activity in the vicinity of his suburban house, caused by traffic over a 24-hour period. White markers indicate 15-minute intervals, black markers indicate change-overs between successive recorded data disk files (see Part 2).

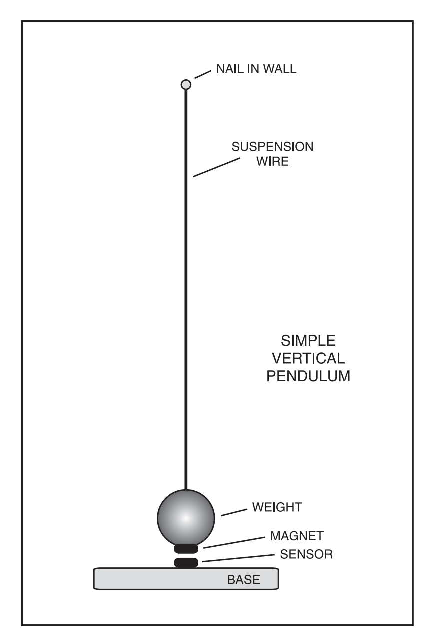


Fig.1. A simple pendulum seismographic sensing assembly.

Typically, a magnet is attached to the weighted end of the pendulum and a magnetic field sensor is fixed to a rigid base in close proximity to the magnet. The sensor reacts to changes in the strength of the magnetic field in response to earth movement.

These changes are detected by electronic circuitry and suitably processed for display or recording purposes. Other sensing techniques are also possible – using opto-electronic pairs such as l.e.d.s and light sensitive devices, for example.

When any pendulum weight is moved out of alignment with its pivot point (the point from which it is suspended), gravity then takes over and tries to pull the weight back to a rest position below the pivot. Like a swing, though, the pendulum weight does not immediately come to rest below the pivot, due to its inertia, but swings somewhat beyond it, and back again, and so on in ever decreasing arcs. As discussed later, the swing cycle can be dampened so that the stable position is more quickly resumed in anticipation of further earth movements.

CLASSIC GOLITSYN

The classic seismograph pendulum is the Golitsyn Gate type (also known as a Garden Gate), as shown simplified in Fig.2. This was used in the author's *Experimental Seismograph* published in *EPE* about 10 years ago. A normal pendulum was also used with that design.

With a Golitsyn Gate, the inner end of an *almost* horizontal beam (it tilts down slightly at the far end) is pivoted against a frame which is firmly secured to a structure embedded in the ground – a house wall for example. The outer end of the beam is weighted, and supported by an angled suspension wire connected to the main frame. A sensor pair is mounted so that any beam movement is detected.

The principles of Simple and Golitsyn pendulums are discussed further in Part 2.

Several other pendulum-based techniques were found during web searches and an easy to build version is described later.

MOVEMENT SENSING

In his previous Seismograph, the author used a magnet and Hall Effect sensor pair to detect pendulum movement. There seemed no reason to change to an alternative method for this new design. The Hall Effect sensor used, however, is a recently introduced type that has better temperature characteristics than the one used before. It is also cheaper!

The magnet type used with the sensor is not critical and probably any disc or bar-type will suffice, such as those used in fridge decorations, for instance. The one in this design has a central hole making its mounting easier.

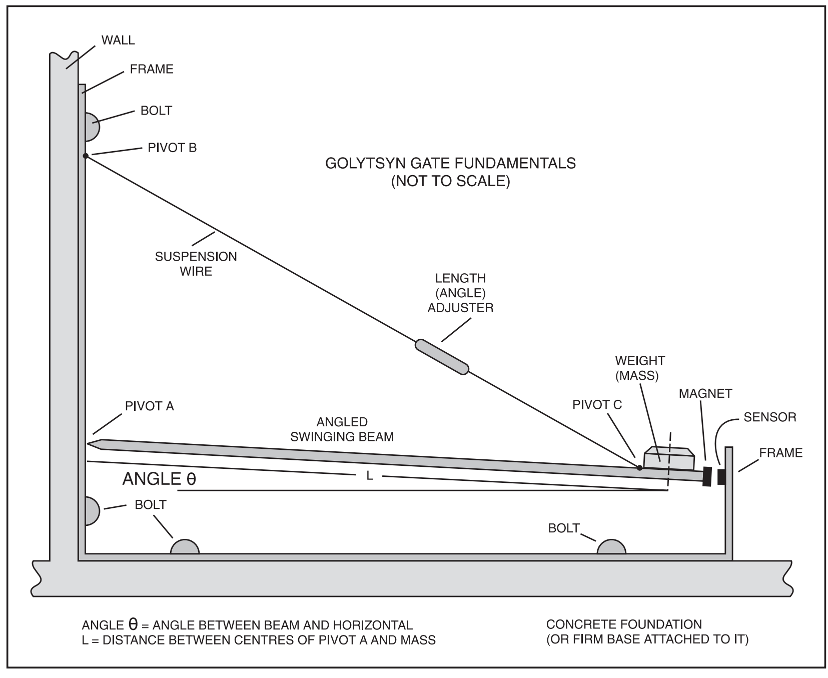


Fig.2. A Golitsyn Gate type of pendulum for sensing seismic activity.

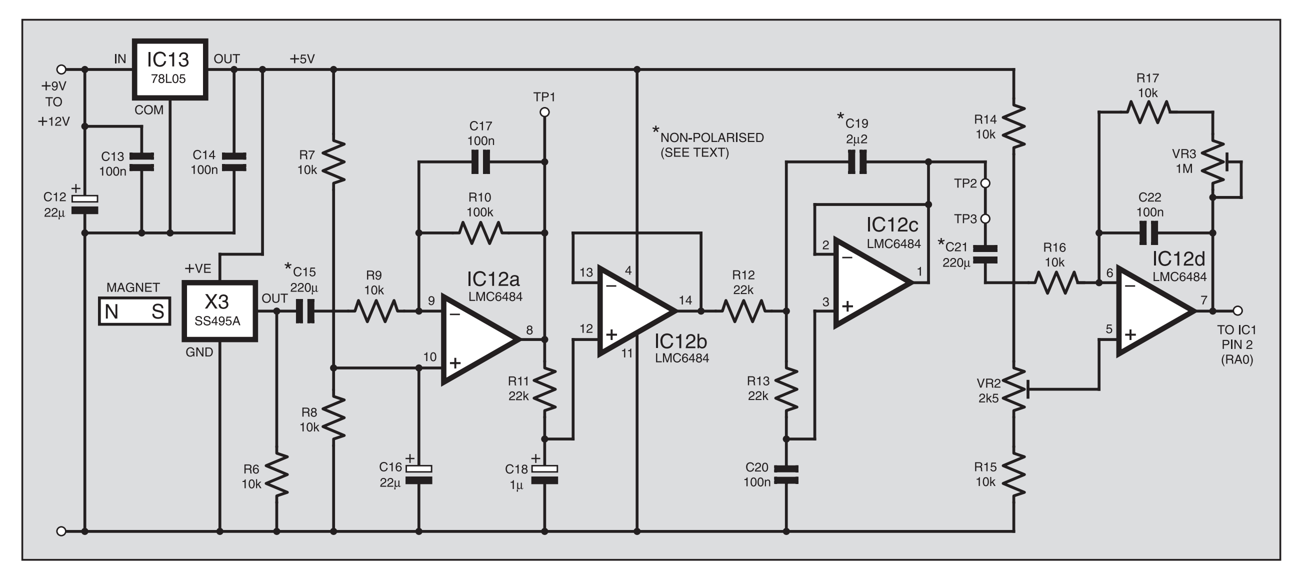


Fig.3. Circuit diagram for the movement sensing amplifier.

The circuit diagram for the movement sensor and its amplifier is shown in Fig.3.

The Hall Effect sensor is notated as X3 and is a Honeywell SS495A device. In the absence of a magnetic field its output rests at about 2·5V when powered at 5V.

The sensor's output is a.c. coupled via capacitor C15 to the ×10 inverting amplifier around op.amp IC12a. The amplified signal is output to the third-order Chebyshev low-pass filter around IC12b and IC12c. This stage eliminates frequencies of about 50Hz upwards, to remove the effects of external influence by a.c. mains currents which may be present near the sensor.

The filtered signal is then a.c. coupled via capacitor C21 to the variable gain stage around IC12d. Here the gain can be varied by preset VR3, between ×1 and about ×100, to adjust the circuit's sensitivity to low level sensor signal changes. The maximum full-circuit gain obtainable is ×1000.

Preset VR2 is used to adjust IC12d's d.c. output bias to a midway voltage when no signals are being received.

It is important to note that capacitors C15, C19 and C21 are *non-polarised* electrolytics. High values of such capacitor types are now commonly available at similar prices to normal polarised capacitors.

If the latter types were to be used instead, correct behaviour of the circuit would be jeopardised. This is due to the fact that a polarised electrolytic requires its positive terminal to be at a voltage equal to or greater than that at its negative terminal. Due to the low frequency signals detected by the sensor, this condition cannot be ensured in a circuit such as this.

However, if non-polarised devices are found hard to obtain in your locality, *two* ordinary polarised electrolytics, each of twice the value specified, may be used in series, with their negative ends joined. In this case C19 would become two 4·7µF capacitors in series (an effective value of about 2·35µF – near enough to 2·2µF). Capacitors C15 and C21 would each be made up from two 470µF capacitors in series (equalling about 235µF).

Power to the sensor circuit is regulated down to +5V by IC13. A separately regulated supply for the sensor circuit was felt

COMPONENTS

Approx. Cost Guidance Only **£40** *excl. case,batt. & pendulum*

See SHOP TALK page

Resistors

R1	1k
R2 to R4, R6 to R9, R14 to R17	10k (11 off)
R5	470Ω
R10	100k
R11 to R13	22k (3 off)

All 0·25W 5% carbon film, or better

Potentiometers

VR1	10k min. round cermet (optional – see text)
VR2	2k5 min. round cermet
VR3	1M min. round cermet

Capacitors

C1, C12, C16	22µ radial elect. 16V (3 off)
C2, C3, C11, C13, C14, C17, C20, C22	100n ceramic disc, 5mm pitch (8 off)
C4, C5	10p ceramic disc, 5mm pitch (2 off)
C6 to C10, C18	1µ radial elect. 16V (6 off)
C15, C21	220µ radial non-polarised elect. 16V (see text) (2 off)
C19	2µ2 radial non-polarised elect. 16V (see text)

Semiconductors

D1	1N4148 signal diode
D2	red l.e.d.
IC1	PIC16F876 microcontroller, pre-programmed (see text)
IC2, IC13	78L05 +5V 100mA voltage regulator (2 off)
IC3	MAX232 RS232 interface
IC4 to IC11	24LC256 serial non-volatile memory (optional – see text) (8 off)
IC12	LMC6484 quad op.amp, rail-to-rail

Miscellaneous

S1, S2	push-to-make switch, p.c.b. mounting (2 off)
SK1	9-pin D-type serial connector, female
X1	3·2768MHz crystal
X2	2-line 16-characters per line alphanumeric l.c.d. (optional, see text)
X3	SS495A Hall Effect sensor



Printed circuit boards, available as a pair from the *EPE PCB Service*, codes 440 (Control) and 441 (Sensor); plastic case 150mm x 80mm x 50mm; 12V heavy-duty battery (see text); 28-pin d.i.l. socket; 16-pin d.i.l. socket; 14-pin d.i.l. socket; 8-pin d.i.l. socket (8-off, see text); 3-way (or 4-way) cable (length to suit); connecting wire; solder, etc.

Pendulum Materials

22mm plastic plumbing pipe (length to suit) (see text)
22mm right-angled plumbing connectors (2 off)
22mm plumbing straight connectors (2 off)
25mm inner dia. flanged plate with securing holes and bolt (curtain rod mounts) (2 off)
eyed bolt, 6mm x 150mm, with securing nuts and washers
metal coat-hanger (pendulum suspension)
5A 2-way terminal block (2 off)
12mm x 12mm right-angled aluminium extrusion (length to suit) (see text)
18s.w.g. tinned annealed copper wire or similar (see text)
1kg weight (see text)
Solid base for pendulum assembly (see text)
Magnet – probably any small disc or bar type – a 20mm (dia) x 10mm with central hole was used in the prototype (RS 260-369)

to be preferable as it is likely to be used at some distance from the main control circuit.

CONTROL CIRCUIT

The complete circuit diagram for the control module is shown in Fig.4. The controlling device is the PIC16F876 microcontroller IC1. This is operated at 3·2768MHz, as set by crystal X1 in conjunction with capacitors C4 and C5.

Analogue output signals from IC12d in Fig.3 are fed to PIC pin RA0, which is used in analogue-to-digital input mode. The PIC samples this input at a rate of 25Hz. Capacitor C12 smooths out any voltage fluctuations picked up along the length of the connecting cable.

The PIC's internal analogue-to-digital converter (ADC) has a resolution of 10 bits, i.e. a range of values from 0 to 1023, in this application representing a voltage range of 0V to 5V.

Each converted value is first output as two bytes to the RS232 serial interface chip IC3, a commonly available and standard device type MAX232. From here is it is output via socket SK1 at 9600 Baud to a PC running the Seismograph's dedicated Windows-based Visual Basic 6 (VB6) software. The software is standalone and does not need VB6 installed in order to run it.

At the PC, the incoming samples can be stored to disk, either at the full 25Hz sampling rate, or at a slower rate as set by the user from within the software. This is discussed later.

At a basic rate of once per second, each converted value is also stored as two bytes to an optional bank of up to eight non-volatile serial memories, IC4 to IC11. These memories retain their data even after power has been switched off. Each device is capable of storing 32,768 bytes of data, and so each chip can store 16,384 samples, with a total bank capacity of 131,072 samples if all eight memories are used.

At the one-second rate, a bank of eight memories can store data across a period of about 2184 minutes, i.e. about 36 hours.

Once the memory bank is full, the bank's address counter is reset to zero and further samples then overwrite the earlier ones. The cycle continues indefinitely.

The PIC software allows the data recording to be set for slower rates if preferred, to as slow as one sample per 128 seconds, as discussed in Part 2.

OPTIONAL L.C.D.

Also at a one-second rate, the values of the data samples are output to an alphanumeric liquid crystal display (l.c.d.), X2, if installed. This also displays the current address to which the data is stored in the memory bank (although this information has no practical use to the user). Preset VR1 controls the l.c.d. screen contrast.

The l.c.d. can also be used when setting sampling rates, and during data download from the memory bank to the computer (for which another data input routine is provided as part of the main program suite).

Note that the use of an l.c.d. is optional since all relevant data is also output to the PC, from where it can be viewed. It is worth mentioning, though, that the l.c.d. can help in the unlikely event that troubleshooting of the control board is needed.

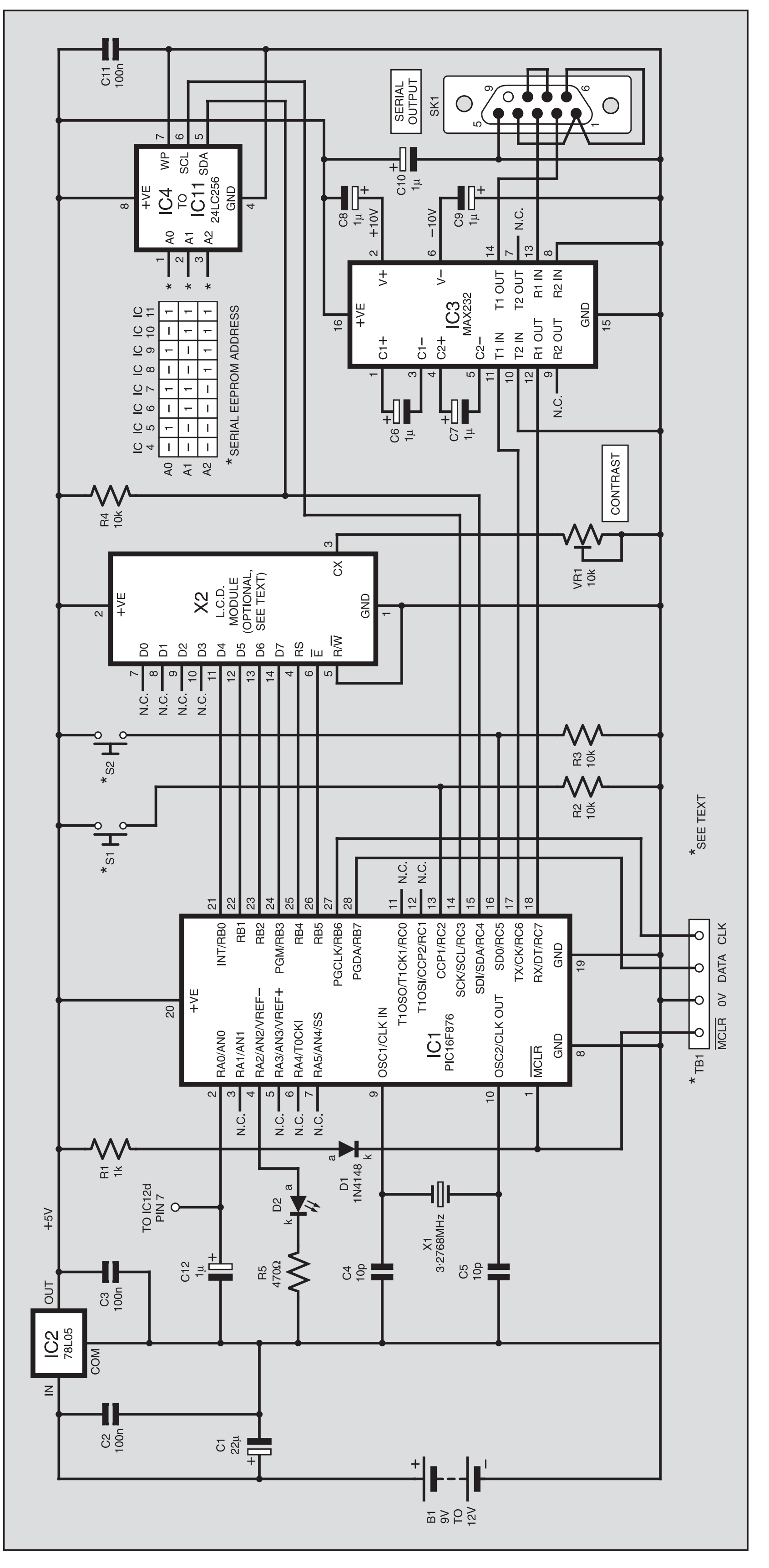


Fig.4. Complete circuit diagram for the main control board. The l.c.d. and serial memory devices (IC4 to IC11) are optional (see text).

Switches S1 and S2 are used to set the sampling rate and download functions. Their roles depend on the mode required, as explained in Part 2.

MEMORY BANK

Returning to the memory bank, the Microchip type 24LC256 devices used

allow eight to be connected in parallel. The chip and its address to which data is written is set by a code value sent serially along the common data line (SDL). This line is biased normally-high by resistor R4, which must be included even if no memory chips are installed (a perfectly valid choice if you prefer to only use the PC as the data recorder).

On the printed circuit board tracks the memories are connected with a specific binary value of between 0 and 7 on their A0 to A2 inputs. This is achieved by connecting the required logic 1 pins to the positive power line track, and leaving the logic 0 pins unconnected as they are internally biased low. The address logic is shown in the inset at the right of Fig.4.

POWER SUPPLY

The entire circuit is intended to be powered from a supply of between 9V and 12V d.c. This is regulated down to 5V by IC2 in respect of the control circuit. Capacitors C1 to C3, plus C11, help to maintain the power line stability.

The separately regulated supply for the sensor board has already been described. It is powered from the same source as the control board.

It is recommended that a 12V car battery is used as the power source rather than a mains powered supply, to prevent data loss should the mains supply fail.

OTHER COMPONENTS

Diode D1, resistor R1 and the terminal pins marked TB1 allow the PIC to be reprogrammed *in-situ* by those who have the author's *EPE Toolkit TK3* (Oct/Nov '01) installed and wish to modify the software to suit their own needs. Both D1 and R1 must be included even if reprogramming is not required.

Note that brand-new PICs should only be programmed for the first time in a dedicated PIC programming board (such as *TK3*), which does not have other components connected to the pins for the PIC's Port B, particularly the pin dedicated for LVP use (RB3).

Light emitting diode D2, buffered by resistor R5, becomes active when the memory bank is being downloaded to the PC.

SOFTWARE

Software, including source code files, for the PIC unit and PC interface is available on 3·5inch disk from the Editorial office (a small handling charge applies – see the *EPE PCB Service* page). It can also be downloaded *free* from the *EPE* Downloads page, accessible via the home page at **www.epemag.wimborne.co.uk**. It is held in the PICs folder, under Seismograph. Download all the files within that folder.

This month's *ShopTalk* provides information about obtaining pre-programmed PICs, and the sourcing of components.

The PIC program source code (ASM) was written using *Toolkit TK3* software (also available via the Downloads page) and a variant of the TASM dialect. It may be translated to MPASM via *TK3* if preferred.

The run-time assembly is supplied as an MPASM HEX file, which has configurations embedded in it (crystal XS, WDT off, POR on, all other values off). If you wish to program the PIC yourself, simply load this HEX file into the PIC using your own PIC programming software and hardware.

The PC interface software was written under Visual Basic 6 (VB6), but you do not need VB6 on your PC in order to run it.

Whether or not VB6 is installed, copy *all* of the Seismograph files (except the PIC files if you prefer) into a new folder called Seismograph, or any name of your choosing, on Drive C (the usual hard drive letter).

If you do not have VB6 installed, you also need three other files, **comdlg32.ocx, Mscommctl.ocx** and **Msvbm60.dll**, held on our 3·5inch disk named Interface Disk 1, and in the Interface folder on our Downloads page (they are also included with the *TK3* software, in Disk 2). These files must be copied into the same folder as the other Seismograph files.

These three files are not supplied with the Seismograph software as they are common to several *EPE* VB6 projects and amount to about 1MB of data.

Additionally, the VB6 source code makes use of Joe Farr's excellent *Serial Interface for PICs and VB6* (Oct '03) software. In order to access (and perhaps modify for your own purposes) the Seismograph VB6 source code files, you need to have Joe's software installed on your PC as well (see his published text). This is also available via our Downloads page.

Without Joe's software installed, if you try to access the Seismograph source code, it will crash.

Note that you should not attempt to "install" the Seismograph VB6 files via Explorer or other similar PC facility. Use Windows' own normal Copy facility.

To run the PC software, simply click on the **Seismograph.exe** icon. Its operation is discussed in Part 2.

CONSTRUCTION

There are two printed circuit boards for this design, the main control board, and the sensor board.

The main board is used in the vicinity of the PC, allowing a standard serial connector lead to be coupled between them. The sensor board is mounted close to the pendulum, which is likely to be in a separate location remote from the PC, since it needs to be mounted on a firm base isolated from undesirable vibration, draughts and abrupt temperature changes.

Alternatively, both boards may be mounted at the pendulum and a twin screened audio cable run from socket SK1 to the PC's COM port socket. In other projects, the author has used serial connections in excess of 21 metres (70 feet) without problems.

The boards are supplied as a pair, available from the *EPE PCB Service* as codes 440 (Control) and 441 (Sensor).

The component and track layout details for the boards are shown in Fig.5 and Fig.6. The author's preferred order of assembly is: wire links (noting that two are under i.c. socket positions), dual-in-line (d.i.l.) i.c. sockets, and then the other components in ascending order of size, correctly observing the orientation of the semiconductors and electrolytic capacitors. Non-polarised capacitors C15, C19 and C21 can be inserted either way round, of course.

There is a link wire between test points TP2 and TP3. Should you wish to experiment with omitting the 50Hz filter network (IC12b and IC12c), remove the link and connect TP1 to TP3.

Do not insert the d.i.l. i.c.s or connect the l.c.d. until the boards have been thoroughly checked for soldering and assembly errors, and the adequacy of the two 5V power

HISTORICAL FRAGMENTS

The earliest known seismograph was invented in China in A.D. 132 by Zhang Heng (78-139 AD). His Earthquake Weathercock consisted of four bronze dragons facing outwards from each other. Each had a ball in its mouth, one of which was supposed to drop into the mouth of a bronze frog below it when an earthquake occurred in that direction! There is more information, plus pictures, at **www.kepu.com.cn/english/quake/relic/rlc04.html**.

In 1703 a certain Monsieur de la Hautefeuille designed an instrument which has been described as the first Western seismograph.

John Mitchell (1724-93) originated the wave theory of earthquake transmission.

In 1855, Italian Luigi Palmieri (1807-1896) invented a device consisting of horizontal mercury-filled tubes with turned up ends. The movements of small iron floats that were attached could be read off on an intensity scale.

The first modern seismograph was invented in 1880 by British geologist John Milne (1850-1913). His invention used a horizontal pendulum and a pen which drew onto a turning drum.

Charles F. Richter devised his logarithmic earthquake peak intensity scale in 1935.

Boris Borisovich Golitsyn, after whom the Golitsyn pendulum is named, was born in St Petersburg on March 2nd 1862, dying in Petrograd on May 16th 1916. From about 1899 onwards, it was he who was responsible for laying down the foundations for modern scientific seismometry.

Earthquakes of magnitude 8·6 occurred on only three occasions in the 20th century. The Chilean triple earthquake of 1960 peaked at 8.9. The average annual energy release from all earthquakes ranges from about 1025 to 1027 ergs, 80% of which is generated by major shocks.

Shallow earthquakes are classified as having origins down to 60km, intermediate ones down to 300km, and deep quakes down to 700km. From records of 5605 shocks in Italy, 90% of the earthquakes originated at depths of less than 8km.

Many earthquake-prone regions have websites devoted to showing current seismic activity. The author has viewed such displays for Iceland and California with astonishment at the amount of daily activity There is also a site for British seismic events (see Part 2).

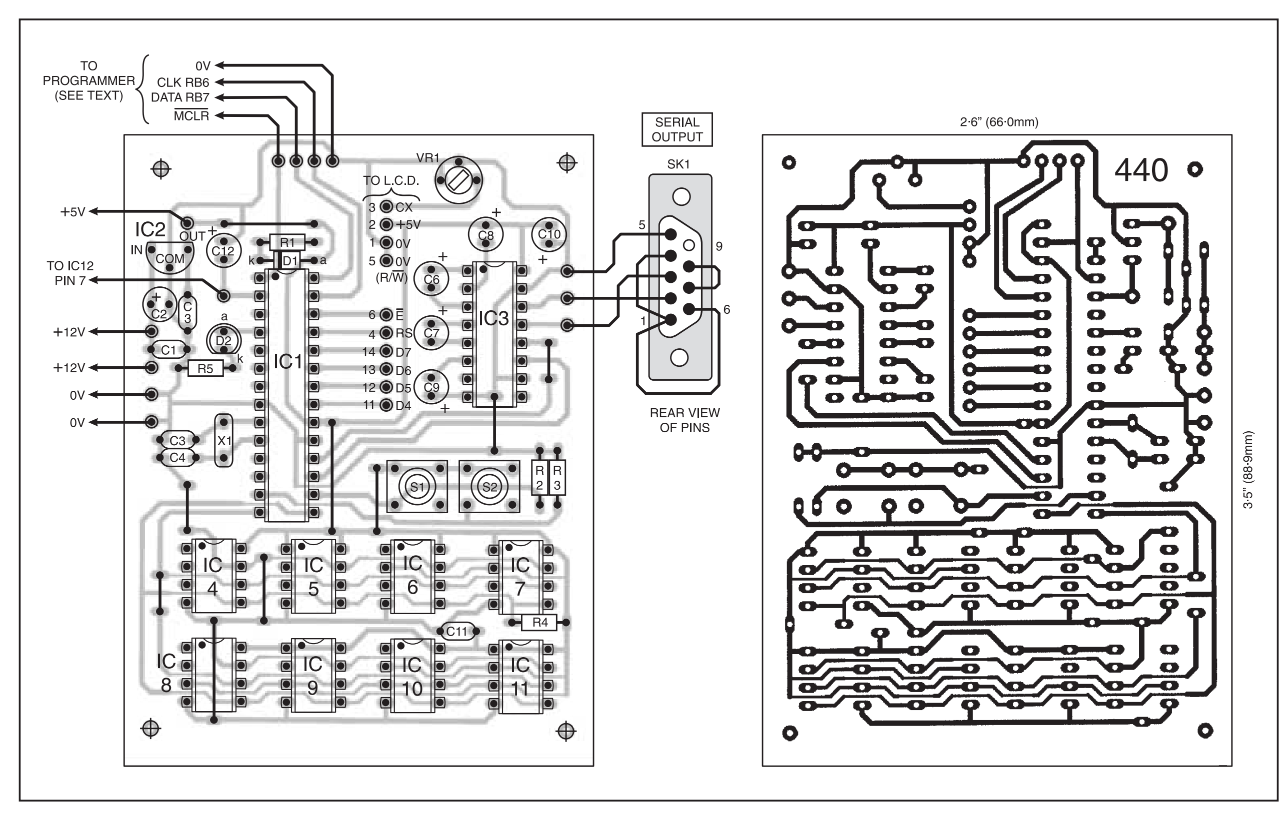


Fig.4. Component layout and master track pattern for the main control printed circuit board. Note that IC4 to IC11 are optional (see text).

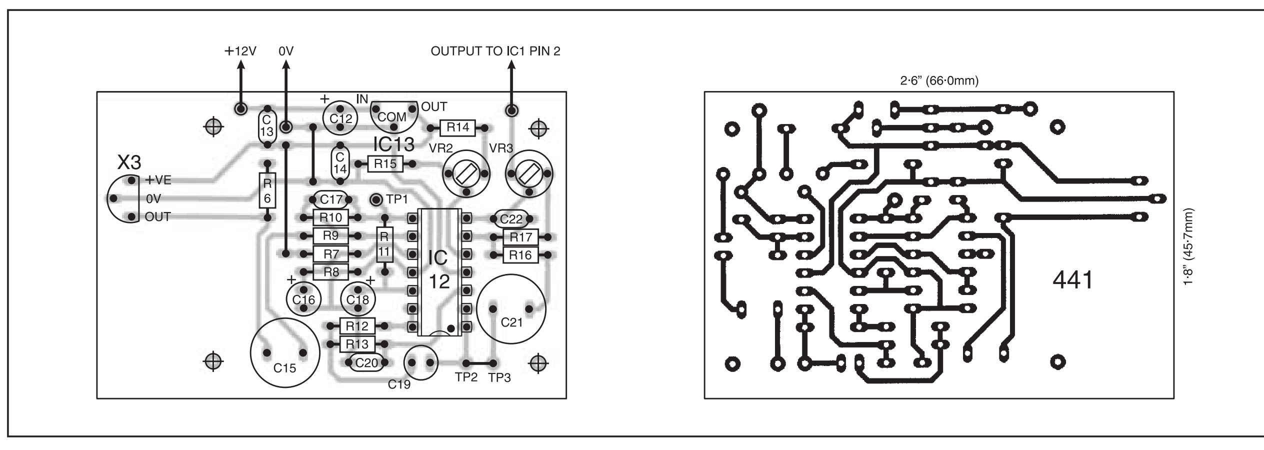
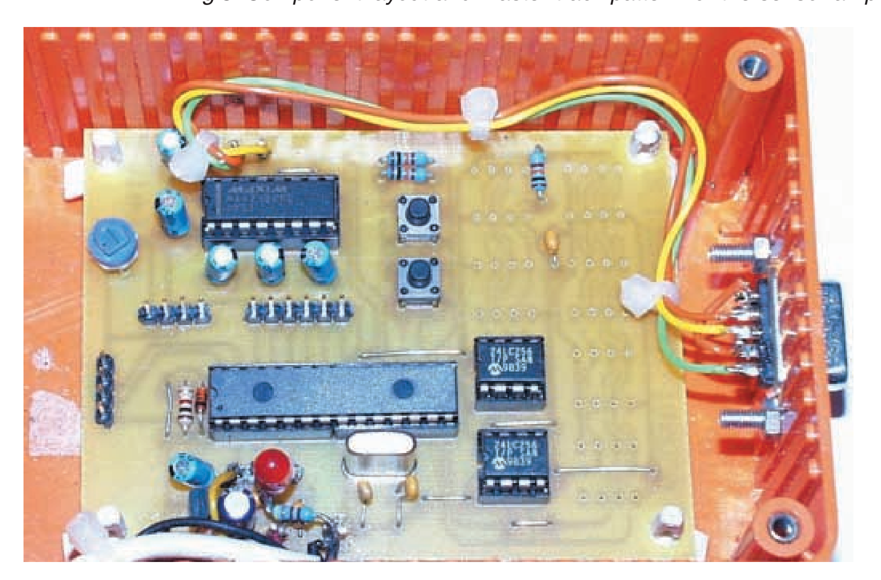
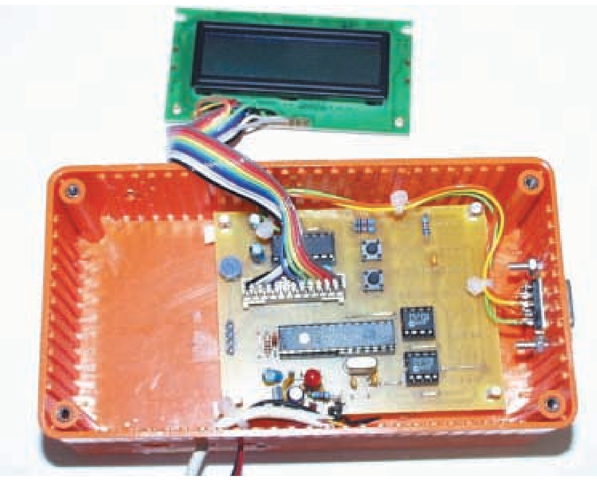


Fig.5. Component layout and master track pattern for the sensor amplifier printed circuit board.







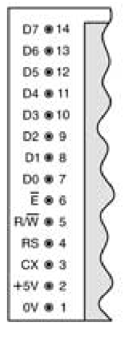


Fig.7. Pinouts for the optional l.c.d.

supplies confirmed. As said earlier, the l.c.d. may be omitted if preferred, in which case omit preset VR1 as well. In the descriptions that follow, it is assumed that the optional l.c.d. is connected.

ENCLOSURE

With the prototype, the main control was mounted in a simple plastic box measuring 150mm × 80mm × 50mm. A slot was cut in one end for socket SK1 and holes through which the battery supply and sensor amplifier cable are passed. Another hole may be drilled if you wish to mount the l.e.d. in the lid. If the optional l.c.d. is used, a viewing slot for it should also be cut in the lid.

As the two switches are likely to be used only rarely, no access holes for them were provided in the test model. If you need to access them, remove the lid.

A case was not used with the sensor board as the sensor needs to be close to the magnet and the pendulum has to be capable of unrestricted movement. Cling film could be used to provide dust protection for the board. Ensure that it is non-conductive.

FIRST CHECKS

The completed circuit board assemblies can be tested without the pendulum mechanics.

Use a multimeter to check the sensor board. First adjust preset VR2 to a midway position, and VR3 to minimum gain (fully clockwise). Apply power and wait a couple of minutes or so for the capacitors to charge to their stable conditions (C15, C19 and C21 in particular are likely to be slow). Now adjust VR2 until the output at IC12 pin 7 is at exactly 2·5V (half supply line voltage).

Monitor the voltage at the output pin of sensor X3, which should be at about 2·5V in the absence of a magnet. Slowly move a magnet side-to-side near it. The voltage reading should change in response. The changes should also be present at IC12 pins 1, 7, 8 and 14. Check that the final output voltage is also present at IC1 pin 2 (RA0).

Be aware that extreme movements of the magnet could cause the circuit to saturate around C15, C19 and C21. If this happens, be patient while the capacitors readjust. The reason for the delay is due to the very low frequency response required by the circuit.

No further sensor board checks or adjustments are needed at this time.

The main control board should work correctly without any adjustment, except to VR1 in order to set the l.c.d. screen contrast.

When power is applied, the PIC software initialises the l.c.d. to work in its 4-bit control mode for two screen lines. Having done so, it then goes through a routine which checks how many serial memories are installed. If you are not using all eight memories, those required should be installed in numerical order starting at IC4. As said earlier, you may omit all memories if you do not want the on-board recording facility (but you must still retain resistor R4, whose bias level is required by the PIC).

The l.c.d. then displays a project identity on the top line, and the number of memory chips on line 2, e.g.:

```
EPE SEISMOGRAPH
8 EEPROM CHIPS
```

After a brief pause, the screen changes to show three values on the top line, in order of the present value read from the sensor amplifier output, between 0 and 1023, followed by the present recording address, between 0 and 32767, and the memory chip to which it refers, between 0 and 7. The first time the unit is used the address and chip selection should both read zero. Line 2 shows the sample delay period selected, a value between 1 and 128, in seconds.

```
  512 12345 0
DELAY 1
```

The software then goes into continuous sampling mode at 25Hz, outputting each sampled value as two bytes to the RS232 chip (IC3) and to the PC. Data recording to the on-board memory bank and updating of the l.c.d. screen display is done at the delay rate selected, one second intervals at this time. The memory address will be seen to change in steps of two since two bytes are recorded for each sample taken. If you move the magnet past the sensor, you will see the displayed sample value updated at the same rate.

Sampling continues indefinitely until the PC interrupts it in order to download the recorded data block. This aspect will be covered when the PC software is described in Part 2.

PIC SAMPLING RATE

The PIC software can be set for the desired recording rate by a routine which can be triggered at the moment that the unit's power is connected. If the power is already connected, disconnect it and wait a few seconds for the power line capacitors to discharge.

Press switch S1 and hold it pressed, then connect the power supply, wait a second or so and then release S1. The l.c.d. screen will show its initial opening display as before, and will then change to show the word SET on the top line and the sample delay rate on line 2.

Pressing switch S2 now causes the sample rate value to increase at a moderate pace in binary steps, in order of 1, 2, 4, 8, 16, 32, 64 and 128 seconds, then rolling over to 1 again, and so on. Releasing S2 while any value is shown causes that value to be selected as the sample rate, which is stored into the PIC's own non-volatile memory for immediate use, and future recall after the unit is next switched on.

If you stop at the wrong number, switch S2 can be pressed again until the required number is shown.

Once the delay rate has been selected, press switch S1 to set the software into its normal sampling and recording mode. The latter is now at the new rate. Note that the 25Hz output rate to the computer is unaffected by the memory bank recording rate.

If you are monitoring via the PC software (described in Part 2), click the PIC Rate button and then observe the rate values in the allocated panel.

MEMORY CLEARANCE

The contents of the memory bank can be reset to zero when desired. This should also be done prior to using the Seismograph in an active mode for the first time.

As a security measure, the process can only be triggered at the moment that the unit is being switched on, as with delay rate selection.

Disconnect the power supply and wait a few seconds. Now press switch S2 and hold it pressed, then reconnect the power supply, wait briefly and release S2. Line 1 then displays the message CLEARING EEPROM, and line two shows the state of the clearance for each of the installed memory chips.

The process is fairly lengthy, taking about three and half minutes for each chip. This is due to the necessary delays required when writing to the memories. Once started, the routine cannot be terminated manually (except by disconnecting the power supply).

When clearance has finished, the recording address count is set to zero and the program reverts to normal sampling.

If you are monitoring via the PC software, click the PIC Clear button, and then observe the clearance progress via the allocated panel.

Note that each time the power supply is disconnected and then reconnected, the memory address count recommences from the value which is last stored to the PIC's own non-volatile memory. The only time that this memory is updated is when Reset mode (memory clearance) has been used, and when data is downloaded to the PC. In the latter instance, once data has been downloaded, the sampling recommences from the address that was current before downloading started.

OVERALL 12cm
(NOT CRITICAL)
NUT AND WASHER
22mm TUBE
NUT AND WASHER
EYED BOLT
RIGHT-ANGLE PIPE COUPLING
WIRE HOOKED OVER EYE
END VIEW OF PIPE
RIGHT-ANGLED ALUMINIUM SECTION
PIPE
RIGID WIRE (COAT-HANGER SECTION)
OVERALL 56cm (NOT CRITICAL)
22mm PLASTIC TUBE (PLUMBING PIPE)
1kg LEAD WEIGHT (SEE TEXT)
TERMINAL BLOCKS
PIPE COUPLING
FLANGED PLATE 26mm (1in) DIA OPENING WITH SCREW HOLES
MAGNET
BOLT
LEVELLING BOLT
SENSOR
PCB
SOLID BASE
EXISTING CONCRETE HOUSE FLOOR
SUSPENSION ROD
5-AMP TERMINAL BLOCK
WIRE HOOK TO SUIT WEIGHT
WIRE HOOK TO SUIT WEIGHT
5-AMP TERMINAL BLOCK
BOLT
NUT AND WASHER
MAGNET
BOLT HEAD
RIGID COPPER WIRE SLIDER
70mm

Fig.8. Details of the assembly for the pendulum mounting.

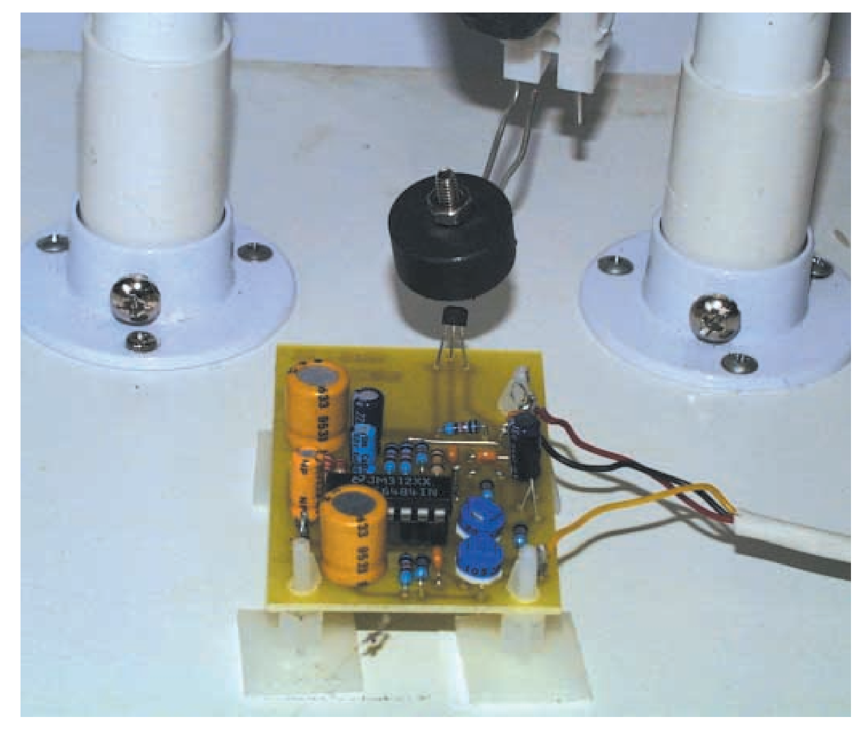
A vital word of caution – keep any software disks well away from the magnet used with the pendulum.

PENDULUM ASSEMBLY

It was commented earlier that browsing the web had revealed several types of pendulum assembly. There is no basic reason why one of these should not be used with the sensor electronics for the Experimental Seismograph Logger. It has to be said, however, that no detailed plans for other assemblies were found, and many appear to be complex assemblies produced by those who have a great love of mechanical constructions for their own sake! Photographs and line drawings were shown in some instances.

The author makes no claim for mechanical sophistication in the pendulum assembly about to be described. It was produced as the simplest assembly that could be imagined (without just resorting to a weight hanging from a large nail), and which would do the job for which it was intended.

Its size, though, is loosely determined by what web searches revealed about other constructions. In them, reference was found to many pendulum lengths, from several metres long to a mere 25cm (10



inches). Somewhat arbitrarily, is was decided that a compromise length of about 50cm would be used.

Perusing the shelves of various major d.i.y. stores, it became apparent that 22mm plastic plumbing pipe (as so often) was the easiest material to work with. The resulting assembly is shown in Fig.8 and the photographs, which are believed to be self-explanatory. All materials for it came from the same d.i.y. store.

It is worth commenting, though, that none of the dimensions are critical, nor is the weight of the pendulum "bob". The 2-pound (approx 1kg) lead weight shown is a remnant of the author's scuba diving days, being one of several worn on a belt to provide neutral buoyancy under water.

If a scuba stockist is not in your locality, alternative materials may be used. The advantage of using lead, though, is that it provides a compact weight-to-size ratio. Lead should also be available from a plumbing materials stockist.

It is not even essential that the weight should be about 1kg. All that is needed is a mass that provides a reasonable amount of inertia. One correspondent on the web said that he had used a Coke can filled with lead.

The vertical plastic plumbing pipe sections are already quite rigid, but they can be given even more rigidity if preferred, by inserting a length of 7·5mm × 7·5mm right-angled aluminium extrusion. There is no reason, however, why copper tubing of 22mm diameter should not be used instead of plastic.

The assembly should be bolted to a concrete floor, either directly or on a solid base which itself is then bolted to the floor. The latter is preferable as it allows levelling bolts to be inserted at its corners (not used with the prototype). A less permanent technique would be to weight the base on the floor using bricks or other heavy materials.

Put a garden-cane cover, or similar, over the upper section of the eyebolt to prevent possible eye injury.

MAGNET POSITION

The sensitivity of the sensor will depend on the magnet strength and the alignment position. A distance of about 0·5 inches (12·5mm) was used with the test pendulum and the magnet specified. It is a matter for which trial and error applies. Either pole of the magnet may face the sensor.

It was found from practical experiment that placing the magnet very slightly to one side of the sensor increased the sensitivity. Vertically, the magnet position can be varied either by means of the threaded eyebolt, or by adjusting the position of the terminal block assembly that holds the magnet. Horizontal alignment can be made by adjusting the position of the magnet on the slider.

It is preferable that the slider should be made from a non-magnetic material, such as 18swg tinned annealed copper wire or 13A earthing wire. Ferrous wire (such as used with coat-hangers) will themselves become part of the magnetic field, so reducing the effectiveness of moving the magnet along the slider.

While adjusting the magnet's position in relation to the sensor, monitor the sensor's output pin with a voltmeter. Do not bring the magnet so close that the sensor's output voltage is too close to either 0V or +5V when the pendulum is motionless. A value of approximately 1·5V was set for the test model. A value 3·5V would have done just as well – about 1V away from the midway voltage. But it is worth experimenting to find a position that provides good sensitivity to *minor* vibrations.

Slight shifting upwards or downwards of the pendulum weight will adjust the pendulum's natural frequency should you wish to do so. In the prototype, with the weight towards the bottom of its supporting rod, the period is about one second. The period shortens if the weight is moved upwards.

FINE TUNING

Be prepared to make alignment corrections for some days after the pendulum has been installed, partly because there may be a certain amount of "settling time", and partly because of information gained in the light of experience.

The same comment applies to the adjustment of the amplifier's gain setting preset VR3. Adjust the gain until the system responds in a way that provides reasonable sensitivity to ground movement waves, without being swamped by traffic or building site events (unless the latter are what you wish to monitor, of course).

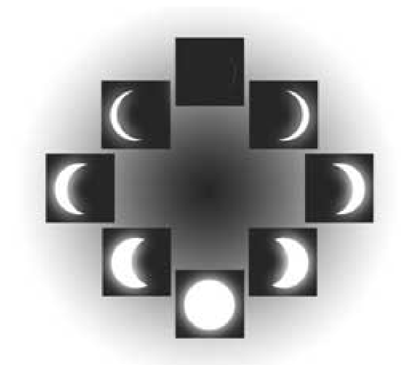
Preset VR2 will also need slight adjusting to centralise the display graphs in their boxes on the PC screen.

Note that the pendulum movement is normally only slight, and may not be apparent to the naked eye. However, you will probably be astonished at the amount of seismic activity, in the broader sense of the phrase, which is picked up by the sensor; described by one source as "a world-wide background of chaotic seismic noise".

NEXT MONTH

In Part 2 next month details of using the specially written PC software will be discussed.

PIC MOON CLOCK



JONATHAN HARE

A timely display for romantics and werewolves!

THERE is something very inspiring (and in the true spirit of experimentation and science) about making a device to better understand the universe around us. Described here is a simple clock consisting of 12 light emitting diodes arranged in a circle, which turn on individually to indicate the current phase of the moon, *new*, *full*, *waxing* and *waning*.

The circuit is based around a PIC-microcontroller. It is easy to build and is suitable for construction by beginners.

CLOCK STABILITY

Timing in clock-type designs is usually something that needs to be done with precision. For example, a wristwatch that deviates by more than a few seconds a day would be regarded as unreliable. Yet an accuracy of a second a day (24 hours = 24 × 60 × 60 = 86400 seconds) requires a precision in the mechanism of roughly 0·001%!

Crystal oscillators are normally used in circuits that require precision, as standard resistor-capacitor (*RC*) oscillator circuits do not have the required stability.

However, the situation is much simpler with this Moon Clock. Its display has 12 l.e.d.s, only one of which is on at any one time. The Moon takes about 29·5 days to orbit the Earth and so each l.e.d. will be on for about 29·5/12 = 2·45 days at a time.

As the clock only needs to show the basic phase of the Moon it really does not matter if the l.e.d.s lose one step over roughly a year (say 12 lunar month cycles = 12 × 12 = 144 l.e.d. steps). This represents an accuracy of better than 1%, which is within the scope of a standard RC timing network.

CIRCUIT DIAGRAM

The complete circuit diagram for the PIC Moon Clock is shown in Fig.1.

There is just one active component, the PIC microcontroller, IC1, a PIC16C54-RC device. As said, it is run in RC mode, at a rate set by capacitor C3, resistor R1 and preset potentiometer VR1. The latter is used to finely adjust the PIC's clock oscillation rate.

The cathodes (k) of the l.e.d.s, D1 to D12, are commoned and feed into a single ballast resistor, R2, as only one l.e.d. is ever on at any time. Switch S2 allows the l.e.d. display to be turned on or off, in the

Phases of the Moon

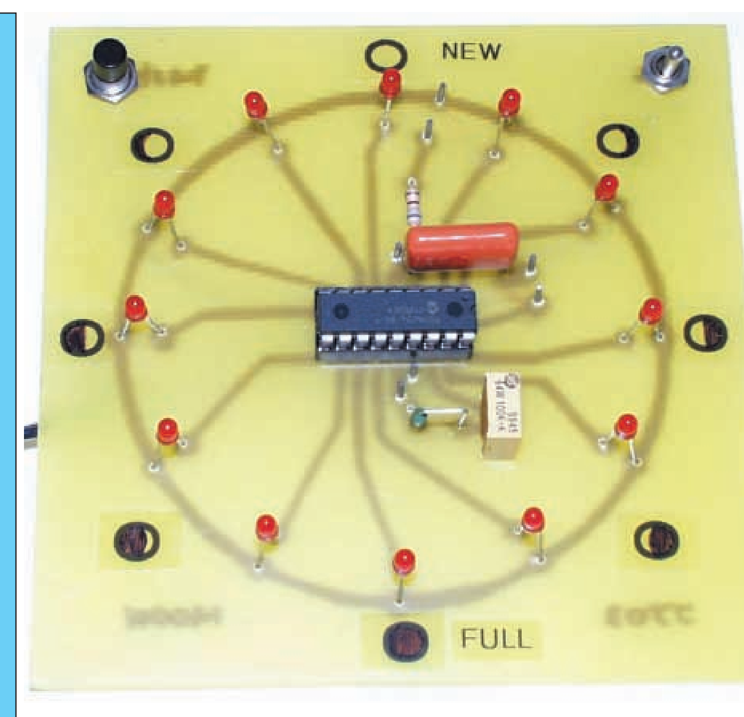
The Moon is about a quarter of a million miles from the Earth and orbits us in about 29·5 days, known as a *lunar month*. The Moon has been vital in all ancient cultures as a clock for dividing up the year. As well as being relevant to folklore and religious festivals, it was used on a day-to-day basis for practical necessities, such as when to sow seeds, or predicting the tides for fishing, for example.

As the Moon orbits the Earth, our view of its relative position to the Sun changes and so we see different proportions of it illuminated. When the Moon is "close" to the Sun, only its far side is illuminated and so we do not see it. A few days later the Moon has moved sufficiently with respect to the Sun so that we start to see a sliver or crescent – the New Moon.

About a week later, the Moon is a quarter of the way around its orbit and we see half of it illuminated. The Moon is then said to be in its First Quarter. This is the best time to see its mountains and valleys. Even through a small telescope or good binoculars it is the most wonderful object in the night sky.

A week later it is half way through its orbit and we see it fully illuminated – a Full Moon. A week later still, it is three quarters of the way round its orbit, and now in its Last Quarter.

A week after this, and a month from the start of the lunar cycle, the cycle is completed, and our side of the Moon is again in darkness. The periods of slow "growth" of the Moon as it appears to develop from New through First Quarter to Full, and its decline from Last Quarter back to darkness are described as the Moon's *waxing* and *waning*.



Prototype PIC Moon Clock printed circuit board. Using a label printer, the moon phase labels have been glued around the circle of l.e.d.s.

interests of power saving. If ultra bright l.e.d.s are used, the display will be very clear for a low current consumption.

Three AA batteries (4·5V) could power the device for many months if the display is turned off when not needed. Alternatively, the use of a mains-derived 5V d.c. supply would allow the clock to be run with the display permanently switched on.

Capacitors C1 and C2 help to stabilise the d.c. power supply. Switch S1 will be discussed presently.

Apart from timing capacitor C3, none of the components are critical. For good stability there is a trade off between the value of resistor R1 (plus VR1) and the value (and physical size) of C3. Electrolytic capacitors are unreliable for this type of oscillator and so a good quality non-polarised capacitor is required.

CONSTRUCTION

The PIC Moon Clock is constructed on a square printed circuit board (p.c.b.), whose component positioning and full-size track layout details are shown in Fig.2 and Fig.3. This board is available from the *EPE PCB Service*, code 442.

A dual-in-line (d.i.l.) socket must be used for IC1 and construction should commence by soldering it in position on the p.c.b. The PIC microcontroller (IC1) should not be inserted in its socket at this stage, but left until the completed construction has been checked for any errors. Take the usual precautions with static and regard the PIC as you would any other CMOS

COMPONENTS

See SHOP TALK page

Resistors
R1 100k
R2 560Ω
All 0·25W 5% carbon film or better.

Potentiometer
VR1 100k 10-turn cermet preset, top adjust

Capacitors
C1 47µF radial elect. 16V
C2 100n ceramic disc
C3 1µF axial, polyester film (non-polarised)

Semiconductors
D1 to D12 ultra-bright red l.e.d. (12 off)
IC1 PIC16C54-RC, preprogrammed (see text)

Miscellaneous
S1 min. push-to-break switch
S2 min. s.p.s.t. toggle switch

Printed circuit board, available from the *EPE PCB Service*, code 442; 1·5V AA batteries (3 off) plus holder (see text); 18-pin d.i.l. socket; connecting wire; solder, etc.

Approx. Cost Guidance Only **£14** *excl. case & batt.*

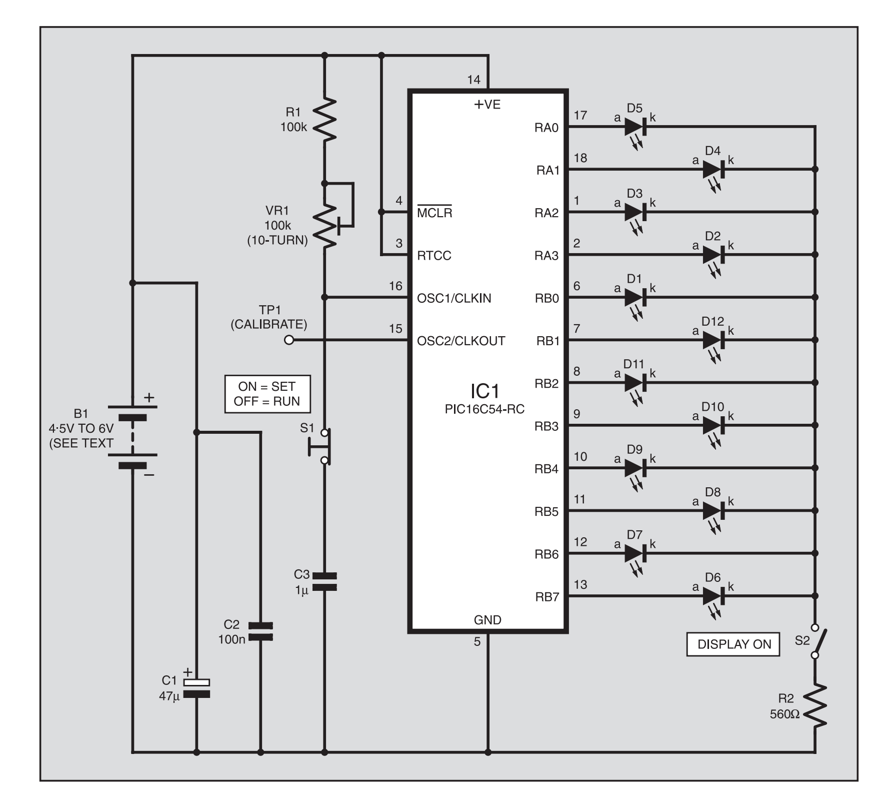


Fig.1. Complete circuit diagram for the PIC Moon Clock.

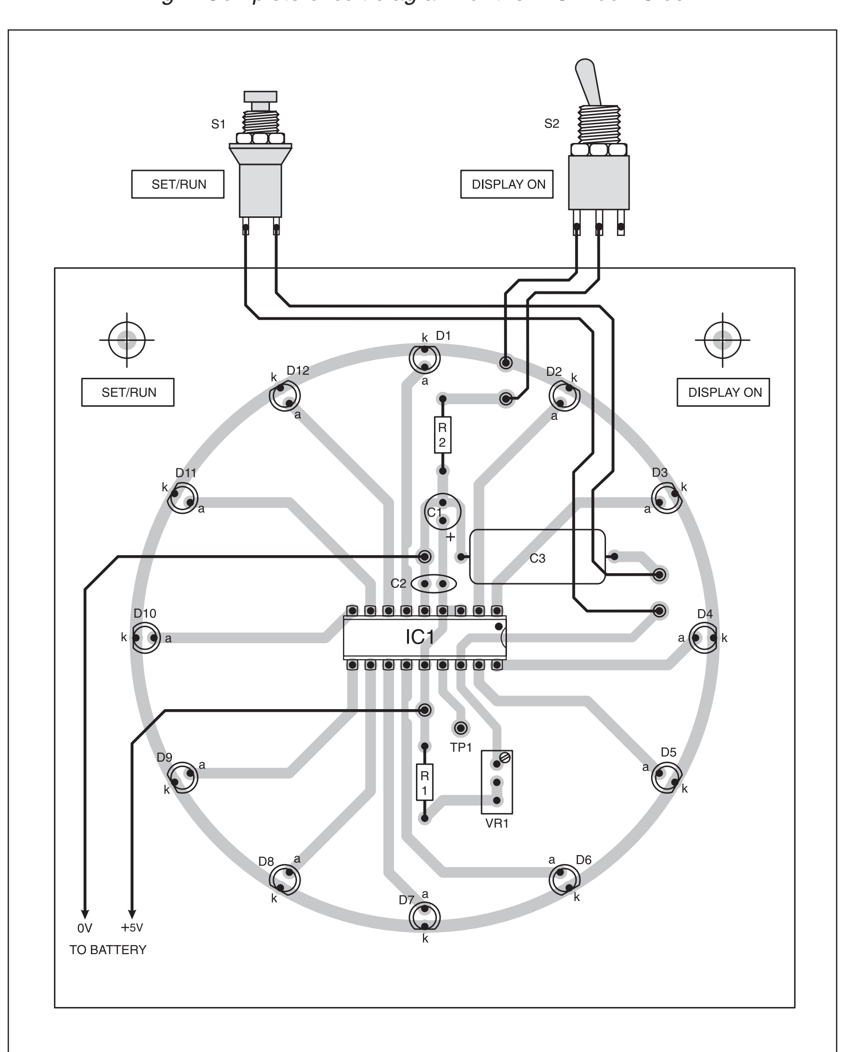


Fig.2. Moon Clock printed circuit board topside component layout and wiring to the two switches.

chip, touching something grounded before handling it, in order to discharge static electricity from your body.

This should be followed by the resistors and capacitors. Capacitor C1 is a polarised miniature electrolytic type and care should be taken to get this the right way round on the p.c.b. before soldering it into position.

Both switches are mounted as shown in the photograph. It is preferable that the wires for S1 should be kept reasonably short in order to prevent the oscillator from being affected by noise pick-up.

For the prototype, a label printer was used to print out notations for the l.e.d. positions, showing the state of the Moon. Rub-down lettering or a marker pen could be used instead.

Completed prototype printed circuit board for the Moon Clock. In this version capacitors C1 and C2 have been wired on the trackside. In the model described here the copper tracking has been modified so that they can be mounted on the component side.

SETTING UP

The current phase of the Moon can be obtained by looking into the sky (at the appropriate time of day!) or by consulting one of the numerous pages on the web. Some daily newspapers also show the Moon's phase.

The l.e.d.s step through the display every two and half days, or so. To set the correct moon phase, it was decided to use the unconventional technique of changing the timing capacitor value, using a push-to-break switch, S1. When the switch is pressed it disconnects timing capacitor C3 and the circuit then oscillates using the PICs internal residual capacitance.

This considerably increases the clock frequency to a few 100kHz, moving the display every second or so until it reaches the correct spot. The capacitor can then be switched back in and the clock left to follow the Moon.

CALIBRATION

As the Moon Clock's oscillator accuracy does not have to be very precise, the circuit calibration is very simple. Attach a multimeter between IC1 pin 15 and ground (0V).

Pin 15 is the PIC's oscillator output pin, at which the frequency is one quarter of the main clock oscillator.

The output pulse rate will be about two pulses per second, and the meter will respond at this rate. An analogue meter will show this more clearly than a digital meter.

While observing a clock with a seconds hand, measure the time it takes for the meter to respond to 100 complete cycles (101 deflections of the meter). This should take about 67 seconds for a calibrated clock. Adjust the 10-turn preset VR1 until it does so. More accurate adjustment can be done over time.

Note that when first switching on the Moon Clock, there are several internal configurations that the PIC needs to do before entering its main timing mode. To avoid a long wait during this initialisation process (due to the very slow oscillator rate), press the Set switch (S1) to allow the process to be completed at the higher clock rate.

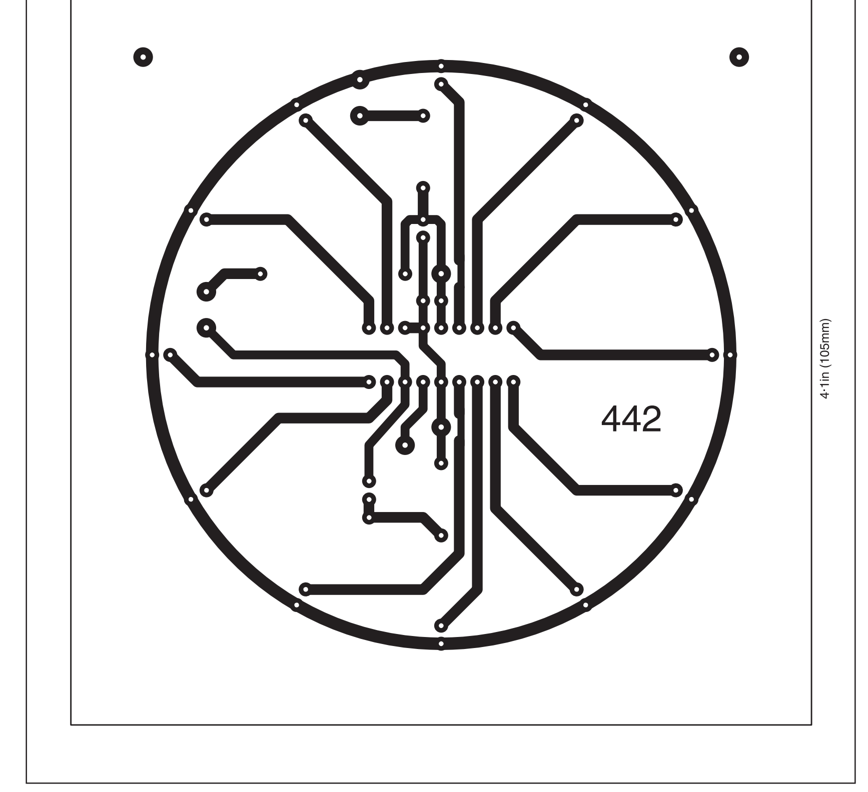


Fig.3. Printed circuit board full-size copper foil master pattern for the Moon Clock.

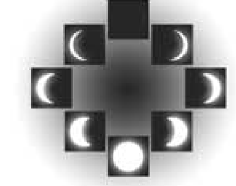
RESOURCES

The software for the PIC Moon Clock is available from the *EPE PCB Service* on 3.5in disk (for which a nominal handling charge applies). It is also available for *free* download from the *EPE* website, accessible via the Downloads click-link on our home page at **www.epemag.wimborne.co.uk** (path **PICs/Moon Clock**). The PIC's configuration is RC oscillator, WDT off, POR on.

See this month's *Shoptalk* page for information on purchasing ready-programmed PICs for the PIC Moon Clock.

Acknowledgement

The author, Dr Jonathan Hare, is a freelance researcher and science communicator. He has worked at the Time and Frequency section of the National Physical Laboratory (he was a "Time Lord" for a year!) and has also appeared on the OU/BBC2's *Rough Science* and *Hollywood Science* TV series. He would like to thank NESTA (National Endowment for Science, Technology and the Arts) for funding and supporting him in this project. □



TECHNO-TALK ANDY EMMERSON

Power In Your Pocket

The latest news on fuel cells that could save the planet – Andy Emmerson's been browsing!

FUEL cells are the new energy-saving technology that's set to save the planet and provide cheap power for portable computers, phones, homes and even cars. It's been a long time coming, though, and not here yet.

There's a delightful TLA (three-letter acronym) by the name of RSN. It stands for "real soon now" and, of course, means nothing of the sort. Fuel cells are a classic RSN technology; they were hailed as the next big thing round about the same time we were told nuclear energy would soon make electricity generation so cheap that metering would be unnecessary.

Fuel cells hit the headlines over 40 years ago and they're doing the same again now. This time round the chief application is portable PCs, PDAs and mobile phones; then it was cars. And whilst people don't seem to mind explosive fuels under the bonnet, they might feel chary about them in their pocket.

Yet the prospect is alluring – smaller, lighter batteries that pack more power and run far longer between charges. They promise greater efficiency, less pollution and the satisfaction of putting brand-new technology to work.

Manufacturers, users and conservationists will all be delighted, since improved batteries could alter notebooks and mobile phones dramatically, making them smaller and more powerful. The new power technology could extend the life of laptops two to three times longer than current batteries, reducing the use of heavy metals and a recycling headache that's growing all the time.

HOW DO FUEL CELLS WORK?

But how do fuel cells work and are they safe? How soon will we see them and who's doing what with them?

Like most other batteries, the fuel cell is an electrochemical energy conversion. In other words, it generates electricity by combining two chemicals and using the reaction to produce an electric current (apologies to anyone who finds my explanation over-simplified!).

The fuel cell process is rather like electrolysis in reverse in that it actually converts hydrogen (you supply this) and oxygen (from the air) into water, producing electricity and heat in the process. It is also a battery that can be recharged while you are drawing power from it, the recharging being with hydrogen and oxygen. Hydrogen, it must be said, is only one of the fuels proposed; another is methanol, as we shall see.

The (theoretically) simplest cells use pressurised hydrogen gas (H_2) entering the fuel cell on the anode side. Forced through a platinum catalyst under pressure, the H_2 molecule divides into two H+ ions and two electrons (e–). The current of electrons then leaves the cell at the cathode. At the cathode oxygen gas (O_2) also meets the catalyst and forms two oxygen atoms, each having a strong negative charge that attracts the two H+ ions to combine with one oxygen atom and two electrons from the external circuit to form a water molecule (H_2O).

The voltage produced by the reaction in a single fuel cell is a mere 0·7V d.c., less than half the 1·5V of a classic dry battery. Combining fuel cells to form a fuel-cell stack is a way of achieving higher voltages.

Like other batteries, fuel cells can be used to power a variety of electrical devices. Differing applications demand different fuel cells and the actual technologies of these devices vary as well. Among the main potential uses of fuel cells are road vehicles (let's say cars) and portable gadgets such as mobile phones, PDAs and notebook computers. Pundits are also talking about home power plants, but it may be a while before we disconnect our homes from the National Grid.

STRANGE CHEMISTRY

There are several different types of fuel cell, each using a different chemistry, and a convenient way of classifying them is by the electrolyte they use. So far we have described hydrogen-oxygen cells but these are not necessarily the most practical solution. Providing (and storing!) ready sources of hydrogen has its drawbacks.

Methanol, also known as wood alcohol, is an alternative to hydrogen. It can be produced from natural gas or from non-petroleum feedstocks such as coal or biomass. Inside this kind of cell, the methanol fuel is mixed with air in the presence of a catalyst coated onto the electrodes. As well as generating electricity, the chemical reaction produces water and carbon dioxide.

It's unclear which particular technology will be selected over the longer term but the most radical solution, developed by scientists at the University of Massachusetts, is a bacterial fuel cell that delivers a low but consistent electric current. In this Pentagon-backed project, the battery's power source is an underground bacterium that gobbles up sugar and converts its energy into electricity.

PERCENTAGES

A prototype device has run flawlessly without refuelling for up to 25 days and is cheap and stable. According to *Alternative Energy News*, its energy efficiency is an extraordinary 83%, which implies that, if engineering obstacles can be overcome and manufacturing techniques devised, it could one day be as compact as household batteries.

As already mentioned, hydrogen is not readily available and has limitations that make it impractical for general use. Other fuels, such as methanol, are more readily available but require the use of a device called a reformer, which turns them into hydrogen. Reformers bring problems of their own, however, generating additional heat and producing unwanted gases. Adding a reformer to convert methanol to hydrogen reduces the overall efficiency to between 30% and 40%.

WHO'S DOING WHAT

The immediate gain will come from the "low-hanging fruit" – compact, long-life batteries for portable devices. Fuel cells for cars and homes are further down the road. One of the leading teams in the field of punchy small batteries is the combination of electronics giant Hitachi and cigarette lighter maker Tokai, both of Japan.

The companies demonstrated a prototype last December based on the direct methanol system. What's more, they intend to produce the cells commercially in 2005 for use in PDAs. According to **news.com**, the prototype cartridge is virtually the size of an AA battery and could power a PDA for six to eight hours. It holds five cubic centimetres of methanol at a concentration of 20%, although the companies are planning to raise the concentration to 30% by the time mass production begins, to increase cell life.

Hitachi and Tokai are not alone in these researches. Toshiba and NEC demonstrated prototypes last year, Toshiba's being a handheld charger for batteries in mobile devices. NEC's battery was said to be able to power a notebook for five hours but they are planning to develop and sell a 40-hour unit by the end of 2005.

IS THIS FINALITY?

Fuel cells are getting closer but they are not yet in reach. Before we see them in the shops, the technology must overcome issues such as water management, volumetric energy density, and packaging, say technology research consultants Allied Business Intelligence.

That said, however, ABI is sufficiently confident to predict that the first 5,000 units of commercial micro fuel cell products in laptops and in niche markets will appear this year or next, with global shipments reaching 200 million units in 2011.

SPECIAL PULL-OUT

SEMICONDUCTOR CLASSIFICATION DATA

Understanding manufacturers' prefix codes

SEMICONDUCTOR devices are classified using a unique part numbering system. Several schemes are in use including the American Joint Engineering Device Engineering Council (JEDEC) system, the European Pro-Electron system, and the Japanese Industrial Standard (JIS) system. In addition, some manufacturers have adopted their own coding schemes based on a manufacturer's prefix followed by a numerical code.

JEDEC SYSTEM

The JEDEC system of semiconductor classification is based on the following coding format:

Leading digit, letter, serial number, suffix (optional)

The leading digit designates the number of *p-n* junctions used in the device. Hence a device code starting with 1 relates to a single *p-n* junction (i.e. a diode) whilst a device code starting with 2 indicates a device that has two *p-n* junctions (usually a transistor). The letter is always N (signifying a JEDEC device) and the remaining digits are the serial number of the device. In addition, a suffix may be used in order to indicate the gain group.

Leading digit – number of *p-n* junctions
1 Diode
2 Transistor
3 Silicon controlled rectifier or dual gate MOSFET
4 Optocoupler

Letter – origin
N North American JEDEC coded device

Serial number
The serial number does not generally have any particular significance

Suffix
Some transistors have an additional suffix that denotes the gain group for the device (where no suffix appears the gain group is either inapplicable or the group is undefined for the device in question):

A Low gain
B Medium gain
C High gain
No suffix = ungrouped (gain undefined)

Examples
1N4001 is a JEDEC-coded diode
2N3055 is a JEDEC-coded transistor
3N201 is a JEDEC-coded dual-gate MOSFET

JAPANESE INDUSTRIAL STANDARD

The Japanese Industrial Standard (JIS) is based on the following coding format:

Leading digit, first letter, second letter, serial number, suffix (optional)

The JIS coding system is similar to the JEDEC system:

Leading digit – number of *p-n* junctions
1 Diode
2 Transistor
3 Silicon controlled rectifier or dual-gate MOSFET
4 Optocoupler

First and second letters – application

SA	*pnp* high frequency transistor
SB	*pnp* low frequency transistor
SC	*npn* high frequency transistor
SD	*npn* low frequency transistor
SE	Diode
SF	Silicon controlled rectifier
SG	Gunn effect device
SH	Unijunction
SJ	*p*-channel FET/MOSFET
SK	*n*-channel FET/MOSFET
SM	Triac
SQ	Light emitting diode (l.e.d.)
SR	Rectifier
SS	Signal diode
ST	Diode
SV	Varactor
SZ	Zener diode

Serial number
The serial number does not generally have any particular significance

Suffix
Some devices have a suffix that denotes approval of the device for use by certain organisations

Examples
1SS90 is a JIS-coded signal diode
2SA1077 is a JIS-coded *pnp* high-frequency transistor
2SK102 is a JIS-coded *n*-channel field effect transistor

Note that the 2S prefix is sometimes omitted from transistor coding. Thus, a transistor of Japanese origin marked A1189 may actually be a 2SA1189 device.

PRO-ELECTRON SYSTEM

The European Pro-Electron system for classifying semiconductors involves the following coding format:

First letter, second letter, third letter (optional), serial number, suffix (optional)

First letter – semiconductor material

A	Germanium
B	Silicon
C	Gallium arsenide, etc.
D	Photodiodes, etc
R	Compound material device

Second letter – application

A	Low power or signal diode
B	Variable capacitance diode
C	Audio frequency low power transistor
D	Audio frequency power transistor
E	Tunnel diode
F	High frequency low power transistor
G	Miscellaneous devices
H	Hall effect diode
K	Hall effect transistor
L	High frequency power transistor
N	Optocoupler
P	Photodiode

Q Light emitting diode (l.e.d.)
R Low power switching device (e.g. diac, thyristor, unijunction)
S Low power switching transistor
T Controlled rectifier/power switching device (e.g. thyristor or triac)
U Power switching transistor
W Surface acoustic wave device
X Frequency multiplier diode (varactor)
Y Rectifier diode
Z Voltage reference (Zener diode)

Third letter

If present this indicates that the device is intended for industrial or professional rather than commercial applications

Serial number

The serial number does not generally have any particular significance

Suffix

Some transistors have an additional suffix that denotes the gain group for the device (where no suffix appears the gain group is either inapplicable or the group is undefined for the device in question)

A Low gain
B Medium gain
C High gain

Examples

AA119 is a Pro-Electron coded germanium low-power signal diode
BFY51 is a Pro-Electron coded silicon high-frequency low-power transistor
BY100 is a Pro-Electron coded silicon rectifier diode
BZY88 is a Pro-Electron coded Zener (voltage reference) diode

MANUFACTURERS' PREFIXES

Code	Manufacturer(s)
A	AMD
ACF	General Instrument
ACP	ITT
ACR	MEDL
ACVP	ITT
AD	Analog Devices
ADC	Analog Devices, General Instrument, Harris, ITT
AH	National Semiconductor
AM	Advanced Micro Devices, AMD
AMU	ITT
AN	Panasonic (Matsushita)
APU	ITT
AR	General Instrument
ARS	General Instrument
ASC	ITT
AW	General Instrument
AY	General Instrument
B	Fagor, General Instrument
BA	Fagor
BAT	ITT, Philips
BAV	ITT, Philips
BAW	ITT
BAX	ITT
BB	ITT
BDM	Analog Devices
BSS	Siemens
BT	Philips
BTA	Thomson
BTB	Thomson
BTW	Thomson
BUD	Thomson
BUF	Thomson
BUL	Motorola, Thomson
BUM	Thomson
BUR	Thomson
BUT	Thomson
BUV	Thomson
BUW	Thomson
BUX	Thomson
BUZ	Harris, Siemens, Thomson
BY	Fagor, Thomson
BYM	General Instrument
BYT	Thomson
BYV	General Instrument, Thomson
BYW	General Instrument
BYW	Thomson
BYX	Thomson
BZV	Thomson
BZW	Thomson
BZX	Thomson
BZY	Thomson
C	AMD, Fairchild, General Instrument, International Rectifier, RCA Harris, Philips
CAP	ITT
CB	International Rectifier, Thomson
CBC	International Rectifier
CC	General Instrument
CCD	Fairchild, ITT
CCU	ITT
CD	Harris, National Semiconductor
CDG	Teledyne
CDP	Harris
CF	General Instrument
CG	General Instrument, STA
CK	General Instrument
CL	General Instrument
CLK	ITT
CM	Harris
CMP	Precision Monolithics Incorporated
CN	Thomson
CP	General Instrument, ITT
CPA	International Rectifier
CPAT	International Rectifier
CPT	International Rectifier
CPU	International Rectifier
CPV	International Rectifier
CPY	International Rectifier
CR	Siliconix
CS	International Rectifier, NECMPANY
CSP	ITT
CT	International Rectifier, Plessey
CTC	International Rectifier
CVPU	ITT
CX	Sony
CXA	Sony
CXB	Sony
CXD	Sony
CXK	Sony
CXL	Sony
D	Harris, Siliconix, Thomson
DAC	Analog Devices, General Instrument, National Semiconductor, Precision Monolithics Incorporated
DAS	Analog Devices
DB	Thomson
DC	Thomson
DF	General Instrument, International Rectifier
DG	General Instrument, Harris, Siliconix
DH	National Semiconductor
DM	National Semiconductor
DMA	ITT
DN	National Semiconductor, NEC, Panasonic
DNO	NEC
DP	International Rectifier, National Semiconductor
DPU	ITT
DS	National Semiconductor
DSC	Analog Devices
DTI	ITT
DTM	Analog Devices
DVR	Precision Monolithics Incorporated
DW	Thomson
E	Thomson
EDF	General Instrument
EF	Thomson
EFG	Thomson
EFR	Thomson
EGL	General Instrument
EGP	General Instrument
EL	ELAN
EM	ITT
EMUS	Thomson
EP	Matsushita, Panasonic
ER	General Instrument
ESM	Thomson
ETC	Thomson
ETL	Thomson
F	Fairchild
FA	NEC
FAOH	NEC
FB	Fagor
FBP	Fagor
FBU	Fagor
FC	NEC
FCD	Fairchild
FCM	Fairchild
FCS	Fairchild
FE	General Instrument
FEP	General Instrument
FES	General Instrument
FIP	NEC
FLC	Fairchild
FLV	Fairchild
FM	NEC
FNA	Fairchild
FND	Fairchild
FPA	Fairchild
FPE	Fairchild
FPT	Fairchild
FSOH	NEC
FZOH	NEC
G	General Instrument, Siliconix
GAL	Lattice Semiconductor, Thomson
GBPC	General Instrument
GBU	General Instrument
GE	General Instrument, Harris
GEM	Harris
GES	Harris
GL	General Instrument
GLL	General Instrument
GP	General Instrument

GPP	General Instrument
GS	Thomson
GSC	Thomson
GSD	Thomson
GT	Sescsem
H	Fairchild, Harris, Hitachi, Thomson
HA	Harris, Hitachi
HAL	ITT
HB	Hitachi
HBF	Thomson
HC	Harris
HCC	Harris
HCF	Harris, Thomson
HCPL	Hewlett Packard
HCTL	Hewlett Packard
HD	Harris, Hitachi
HDSP	Hewlett Packard
HE	International Rectifier
HEDS	Hewlett Packard
HEF	Philips
HEMT	Hewlett Packard
HFA	Harris, International Rectifier
HFBR	Hewlett Packard
HI	Harris, National Semiconductor
HLCP	Hewlett Packard
HLMP	Hewlett Packard
HM	Harris, Hitachi, MHS
HN	Hitachi
HSMP	Hewlett Packard
HSMS	Hewlett Packard
HSMX	Hewlett Packard
HSMY	Hewlett Packard
HSSR	Hewlett Packard
HTA	Thomson
HTIL	Hewlett Packard
HV	Harris
HXTR	Hewlett Packard
IC	NEC
ICL	Harris
ID	Hesmi
IGT	Harris
IH	Harris
IL	Ittronix
IM	Harris, INMOS
IMS	Thomson
IMST	INMOS
IP	Harris
IR	International Rectifier
IRC	International Rectifier
IRCC	International Rectifier
IRCP	International Rectifier
IRCZ	International Rectifier
IRD	International Rectifier
IRF	Harris, International Rectifier, Thomson
IRG	International Rectifier
IRH	International Rectifier
IRK	International Rectifier
IRL	International Rectifier
IRT	ITT
IS	Harris
ISB	Thomson
ISP	ITT
IT	Harris
ITA	Thomson
ITT	ITT
J	Harris, Siliconix
JA	ITT
JAN	International Rectifier
JC	ITT
K	International Rectifier
KB	General Instrument
KBPC	International Rectifier
KR	Standard Microsystems
L	Siliconix, Thomson
LA	Lambda
LCP	Thomson
LD	Harris
LF	Motorola, National Semiconductor, Philips, Texas Instruments, Thomson
LH	National Semiconductor, Philips, Siliconix
LL	ITT
LM	Fairchild, Harris, Linear Tech, National Semiconductor, Philips, Siliconix, Texas Instruments, Thomson
LOP	Thomson
LP	General Instrument, Harris, National Semiconductor
LS	Thomson
LT	Linear Tech
LTC	Linear Tech
LTK	Linear Tech
LZ	ITT
M	Mitsubishi, Thomson
MAB	Philips
MAC	Motorola
MAF	Philips
MB	Rectron
MBD	Motorola
MBR	General Instrument, International Rectifier, Motorola
MC	Harris, General Instrument, Motorola, NEC, Thomson
MCM	Motorola
MCR	Motorola
MCT	Motorola
MCU	ITT
MDA	ITT, Motorola
MDC	Motorola
MDS	Thomson
MEM	General Instrument, Harris
MFE	Motorola
MFO	Motorola
MIC	ITT
MJ	Harris, Motorola, Thomson
MJD	Motorola
MJE	Harris, Motorola, Thomson
MJF	Motorola
MJH	Motorola
MK	Mostek, Motorola, Thomson
ML	Plessey, Thomson
MLED	Motorola
MLM	Motorola
MM	Motorola
MM	National Semiconductor
MN	Panasonic
MO	Motorola
MOC	Motorola
MOD	Siliconix
MP	Toshiba
MPF	Motorola, National Semiconductor
MPG	General Instrument
MPM	Motorola
MPN	Motorola
MPQ	Motorola, Thomson
MPS	Motorola
MPSA	Motorola
MPSH	Motorola
MPSL	Motorola
MPSU	Motorola
MPSW	Motorola
MPTE	Motorola
MPX	Analog Devices, Motorola
MPY	Burr Brown
MR	Fagor, Motorola
MRF	Motorola
MRO	Motorola
MSD	Motorola
MSE	ITT
MSM	OKI
MSP	ITT
MSS	Thomson
MTA	Motorola
MTD	Motorola
MTE	Motorola
MTH	Motorola, Thomson
MTM	Motorola
MTP	Motorola, Thomson
MU	Motorola
MUR	Harris, Motorola
MUX	General Instrument, Harris
MV	Motorola
MVAM	Motorola
MZD	Motorola
N	Philips
NA	Harris
NE	Philips, Thomson
NOM	Plessey
NP	General Instrument
NPF	General Instrument
NR	Harris
NS	General Instrument
NSF	General Instrument
NVM	ITT
OP	Plessey, Precision Monolithics
P	AMD, General Instrument, Harris, International Rectifier, Motorola, Thomson
PA	Philips
PBL	Thomson
PCA	Philips
PCB	Philips
PCD	Philips
PCF	Philips
PFR	Thomson
PIC	General Instrument, Harris, Unitrode, Microchip
PIP	ITT
PL	Thomson
PLQ	Thomson
PM	General Instrument, Harris, Precision Monolithics
PNA	Philips
PP	General Instrument, Harris
PS	NEC
PSP	ITT
PVA	International Rectifier
PVD	International Rectifier
PVI	International Rectifier
PVPU	ITT
PVR	International Rectifier
R	International Rectifier
RA	General Instrument, Harris, Raytheon
RAY	Raytheon
RC	Raytheon
RCA	Harris
RCR	ITT
RCT	ITT
REF	Precision Monolithics
RF	Harris
RG	General Instrument
RGL	General Instrument
RGP	General Instrument
RM	General Instrument, Harris, Raytheon
RMP	General Instrument
RO	General Instrument, Harris, ITT
RRF	Harris

RS	General Instrument
RTI	Analog Devices
RUR	Harris
S	International Rectifier, Seiko Instruments, Siemens, TAG Semiconductors
SA	Philips, Thomson
SAB	Philips
SAC	Analog Devices
SAD	ITT
SAF	ITT
SAJ	ITT, Thomson
SAK	ITT
SAN	ITT
SAS	Siemens
SB	General Instrument
SBA	General Instrument, Harris
SBL	General Instrument
SBLF	General Instrument
SBP	Texas Instruments
SC	International Rectifier
SD	International Rectifier, Philips, Teledyne
SDA	Thomson
SE	Philips, Thomson
SFC	Sescosem
SG	Harris, Philips, Silicon General, Siliconix, Sprague, Thomson
SGL	General Instrument
SGS	Thomson
SGT	Harris
SH	Fairchild
SHA	Analog Devices
SI	Siliconix
SKB	Semikron
SKD	Semikron
SKKD	Semikron
SKKH	Semikron
SKKT	Semikron
SL	General Instrument, Harris, Plessey
SM	General Instrument, Harris, Philips, Semelab, Silicon General, Thomson
SML	Semelab
SMM	Siliconix
SMP	Precision Monolithics, Siliconix
SMV	Siliconix
SMW	Siliconix
SMX	Analog Devices
SN	Texas Instruments
SO	Thomson
SOC	Analog Devices
SP	Harris, International Rectifier, Plessey
SPBM	Siliconix
SPMF	Siliconix
SPU	ITT
SR	Standard Microsystems
SRP	General Instrument
SRX	Analog Devices
SS	General Instrument, Harris GO
SSC	Analog Devices, International Rectifier
SSM	Precision Monolithics
SSS	Precision Monolithics
ST	Thomson, International Rectifier
STF	Thomson
STGH	Thomson
STGP	Thomson
STH	Thomson
STHV	Thomson
STK	Thomson
STKM	Thomson
STLT	Thomson
STP	Thomson
STPR	Thomson
STPS	Thomson
STVH	Thomson
STY	Thomson
SU	Philips
SW	Plessey
T	General Instrument, Harris, International Rectifier, TAG, Thomson, Transitron
TA	Toshiba
TAA	Fairchild, ITT, Philips, Siemens, Thomson
TBA	Fairchild, ITT, Philips, Siemens, Thomson, Telefunken
TBB	Siemens
TBC	Siemens
TBE	Siemens
TC	Teledyne, Toshiba
TCA	ITT, Philips, Siemens, Telefunken
TD	Toshiba
TDA	Fairchild, ITT, Philips, Siemens, Telefunken, Thomson
TDB	Siemens, Thomson
TDC	Siemens, Thomson
TDD	Philips
TDE	Thomson
TDF	Thomson
TDP	Thomson
TEA	Philips, Telefunken, Thomson
TEB	Thomson
TEF	Thomson
TF	Transitron
TFF	Transitron
TFIR	ITT
TFPO	ITT
TG	Transitron
TGAL	Thomson
TGDV	Thomson
TGF	Thomson
TGL	General Instrument
TH	Toshiba
THBT	Thomson
THDT	Thomson
THM	Toshiba
TIN	Toshiba
TIP	Harris, Texas Instruments, Thomson, Toshiba
TL	Texas Instruments, Thomson
TLC	Texas Instruments, Thomson
TLG	Toshiba
TLO	Toshiba
TLR	Toshiba
TLRA	Toshiba
TLRC	Toshiba
TLS	Thomson, Toshiba
TLSG	Toshiba
TLUR	Toshiba
TLY	Toshiba
TM	Thomson, Toshiba
TMM	Thomson
TMP	Toshiba
TMS	Texas Instruments
TNG	Transitron
TOA	Transitron
TODV	Thomson
TOSH	Toshiba
TP	Teledyne
TPA	Thomson
TPB	Thomson
TPDV	Thomson
TPO	Sprague
TPP	Thomson
TPS	Toshiba
TPU	ITT
TRAL	Thomson
TRC	Transitron
TS	Thomson, Toshiba
TSA	Philips
TSD	Thomson
TSFJ	Thomson
TSFK	Thomson
TSG	Thomson
TSGF	Thomson
TSGS	Thomson
TSL	Analog Devices
TSOC	Analog Devices
TVPO	ITT
TXDV	Thomson
TYF	Toshiba
TYN	Thomson
TYP	Thomson
TYS	Thomson
TZ	General Instrument, Harris
U	Fairchild, Telefunken
UA	Fairchild, National Semiconductor, Philips, Texas Instruments, Thomson
UAA	ITT, Siemens, Telefunken, Thomson
UAF	ITT, Thomson
UC	Linear Tech, Thomson, Unitrode
UCN	Sprague
UCS	Sprague
UDN	Philips, Sprague
UDS	Sprague
UF	General Instrument
UHD	Sprague
UHP	Sprague
UIS	Sprague
ULC	Sprague
ULN	Philips, Sprague, Thomson
ULQ	Thomson
UPB	NEC
UPC	NEC, Standard Microsystems
UPD	NEC
V	Harris
VAD	ITT
VB	Thomson
VCU	ITT
VDU	ITT
VN	Teledyne, Thomson
VSP	ITT
W	General Instrument
X	TAG Semiconductors
XR	Exar
Y	Texas Instruments
YTFP	Toshiba
Z	International Rectifier, Thomson
ZA	Texas Instruments, ZETEX
ZAD	Texas Instruments, ZETEX
ZD	International Rectifier
ZEL	Texas Instruments, ZETEX
ZGL	General Instrument
ZGP	General Instrument
ZMM	ITT
ZMU	ITT
ZMY	ITT
ZN	Ferranti, ITT, Plessey
ZPD	ITT
ZPU	ITT
ZPY	ITT
ZS	Ferranti, Plessey
ZTE	ITT
ZTX	Ferranti, ITT
ZY	ITT
ZZ	ITT
ZZY	ITT

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EVERYDAY PRACTICAL ELECTRONICS BACK ISSUES

We can supply back issues of *EPE* by post, most issues from the past three years are available. An *EPE* index for the last five years is also available at **www.epemag.wimborne.co.uk** or see order form below. Alternatively, indexes are published in the December issue for that year. Where we are unable to provide a back issue a photocopy of any *one article* (or *one part* of a series) can be purchased for the same price. Issues from Nov. 98 are available on CD-ROM – see next page – and issues from the last six months are also available to download from **www.epemag.com**. Please make sure all components are still available before commencing any project from a back-dated issue.

DID YOU MISS THESE?

DEC '02

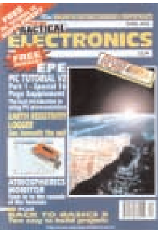
PROJECTS ● Versatile PIC Flasher ● *EPE* Hybrid Computer – 2 ● Door Defender ● PICAXE Projects – 2 (Temperature Sensor – Voltage Sensor – VU Indicator).
FEATURES ● Electronic Paper ● Alternative Uses for Transistors ● Interface ● Circuit Surgery ● New Technology Update ● Ingenuity Unlimited ● Net Work – The Internet Page ● 2002 Annual Index.

JAN '03

PROJECTS ● *EPE* Minder ● F.M. Frequency Surfer ● Wind Speed Meter ● PICAXE Projects–3 (Chaser Lights).
FEATURES ● Who Really Invented The Transistor ● TechnoTalk ● Circuit Surgery ● Practically Speaking ● New Technology Update ● ● Ingenuity Unlimited ● Net Work – The Internet Page.

FEB '03

PROJECTS ● Wind Tunnel ● Brainibot Buggy ● Back To Basics–1 (Hearing Aid, Audio Power Amplifier) ● Tesla High Voltage Transformer.
FEATURES ● In The Bag ● Techno Talk ● Circuit Surgery ● New Technology Update ● Interface ● Ingenuity Unlimited ● Net Work – The Internet Page.





MAR '03

PROJECTS ● Wind-Up Torch Mk II ● 200kHz Function Generator ● Driver Alert ● Back-To-Basics–2 (Metal Detector, Simple Timer).
FEATURES ● Ingenuity Unlimited ● Practically Speaking ● Techno Talk ● New Technology Update ● Circuit Surgery ● Peak LCR Component Analyser Review ● Net Work – The Internet Page.

APR '03

PROJECTS ● Atmospherics Monitor ● Intelligent Garden Lights Controller ● Back-To-Basics–3 (Touch Light, Plant Watering Reminder) ● Earth Resistivity Logger–Part 1.
FEATURES ● Ingenuity Unlimited ● Techno Talk ● New Technology Update ● Circuit Surgery ● Interface ● Network – The Internet Page ● *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2–Part 1.

MAY '03

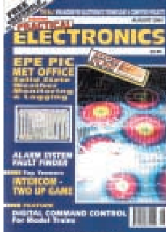
PROJECTS ● Super Motion Sensor ● Earth Resistivity Logger – Part 2 ● Door Chime ● Back-To-Basics–4 (Live Wire Detector, Medium Wave Radio).
FEATURES ● Ingenuity Unlimited ● Techno Talk ● Practically Speaking ● Circuit Surgery ● Net Work – The Internet Page ● *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2 – Part 2.

JUNE '03

PROJECTS ● Fido Pedometer ● PICronos L.E.D. Wall Clock–Part 1 ● Back-To-Basics–5 (Mini Theremin, Twilight Switch) ● Radio Circuits–1 (Crystal Set, MK484 TRF Receiver, Headphone Amplifier).
FEATURES ● Ingenuity Unlimited ● Techno Talk ● Interface ● Circuit Surgery ● New Technology Update ● Net Work – The Internet Page ● *SPECIAL SUPPLEMENT* – EPE PIC Tutorial V2 – Part 3.

JULY '03

PROJECTS ● EPE Mini Metal Detector ● Low Range Ohmmeter Adaptor Mk2 ● Radio Circuits–2 (Q-Multiplier, MW Reflex Radio, Speaker Amplifier) ● Ultimate Egg Timer ● PICronos L.E.D. Wall Clock – Part 2.
FEATURES ● Ingenuity Unlimited ● Circuit Surgery ● Techno Talk ● Practically Speaking ● Flowlog Lite Review ● Net Work–The Internet Page.





AUG '03

PROJECTS ● EPE PIC Met Office–1 ● Alarm System Fault Finder ● Master/Slave Intercom ● Electronic Two-Up ● Radio Circuits–3 (Regenerative Receivers).
FEATURES ● Digital Command Control for Model Trains ● Ingenuity Unlimited ● Circuit Surgery ● Interface ● Techno Talk ● New Technology Update Net Work – The Internet Page.

SEPT '03

PROJECTS ● PIC-A-Colour ● Vibration Alarm ● Priority Referee ● EPE PIC Met Office–2 ● Radio Circuits–4 (Tuning Systems).
FEATURES ● Using the PIC's "High" Operator ● Practically Speaking ● Ingenuity Unlimited ● Techno Talk ● Circuit Surgery ● Net Work – The Internet Page.

OCT '03

PROJECTS ● RC Car Wars ● Serial Interface for PICs and VB6 ● Practical Radio Circuits–5 (Super Regen. Receiver) ● Spooky Bug.
FEATURES ● PIC Breakpoint ● Ingenuity Unlimited ● Interface ● Techno-Talk ● New Technology Update ● Net Work – The Internet Page.

NOV '03

PROJECTS ● PIC Random L.E.D. Flasher ● Cardboard Clock ● Practical Radio Circuits–6 (S.S.B. and Direct Conversion Receiver) ● Anyone At Home?
FEATURES ● Teach-In 2004 – Part 1 ● Ingenuity Unlimited ● Practically Speaking ● Techno Talk ● Circuit Surgery ● New Technology Update ● Net Work – The Internet Page.

DEC '03

PROJECTS ● PIC Nim Machine ● Practical Radio Circuits–7 (Superhet Tuner) ● PIC Virus Zapper Mk2 ● Christmas Cheeks.
FEATURES ● Teach-In 2004 – Part 2 ● Electrotherapy ● Circuit Surgery ● Ingenuity Unlimited ● Techno Talk ● High-Speed Decimal To Binary For PICs ● Interface ● Network – The Internet Page.

JAN '04

PROJECTS ● Car Computer ● Practical Radio Circuits–8 (Dual-Conversion SW Receiver) ● Bedside Nightlight ● PIC Watering Timer.
FEATURES ● GPS to PIC and PC Interface ● Practically Speaking ● Teach-In 2004 – Part 3 ● Ingenuity Unlimited ● Techno Talk ● Circuit Surgery ● New Technology Update ● Net Work – The Internet Page.





FEB '04

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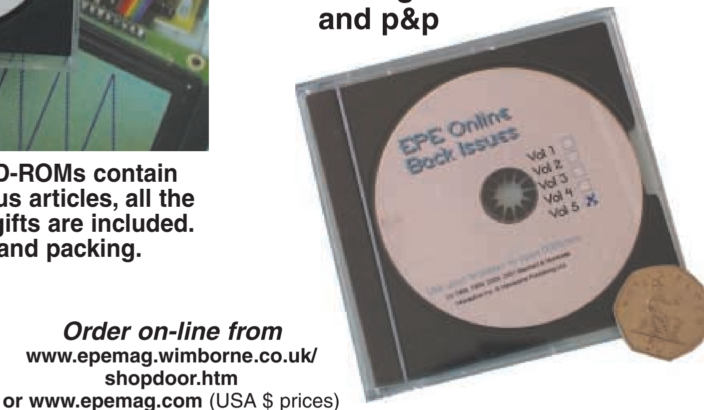
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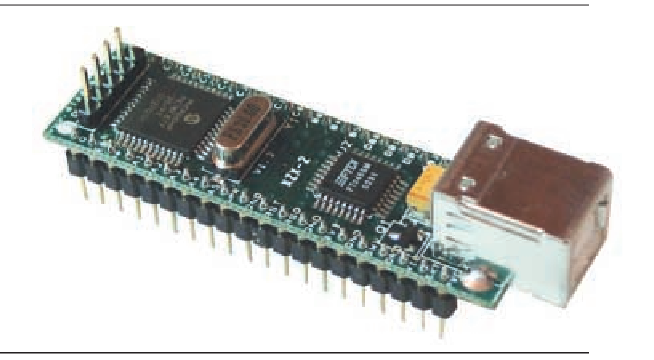
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Special Review

USB TO PIC INTERFACE



JOHN WALLER

Investigating a Universal Serial Bus (USB) to PIC microcontroller interface, the DLP-245PB module

ANY computer purchased in the last few years is almost certain to be fitted with one or more USB (Universal Serial Bus) connectors. The intent of USB is to replace ageing parallel and serial interfaces in computer systems. Some of these interfaces are still based on technology that pre-dates the modern computer.

While not the fastest form of computer interface, USB is designed to be easy to set up, user-friendly, and possesses a bus architecture which enables data from many devices to be funnelled into and out of a computer in an orderly manner. See **www.noccc.org/bytes/articles/v01/326.html** for more information.

This review describes a USB to PIC interface module, the DLP-245PB, which is marketed by DLP Design (see later). In terms of this review, the host computer is always in charge of USB operations. The connecting cables are made up of four wires, two for data, and two for power supply (+5V and ground). USB operates at either 1·5 or 12 megabits per second.

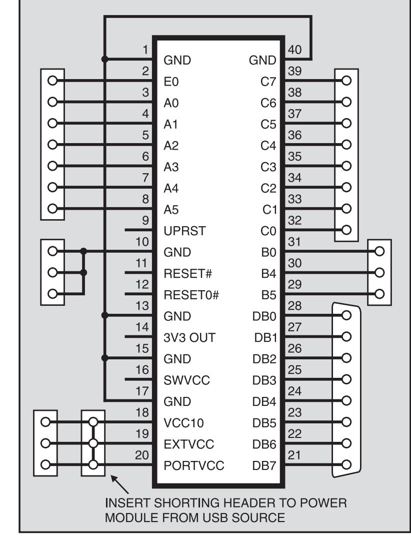


Fig.1. Pinouts and initial test connections for the DLP-245PB module.

For test purposes the DLP-245PB module was inserted in a ZIF socket mounted on stripboard.

Devices which do not need much power may draw it through the bus. This is useful for downloading data from a battery operated device, such as a camera. The USB cable used here contains an "A" end connector, which has four pins in line at the computer end. The peripheral "B" end has four pins at the corners of a rectangle. There are also "A" to "A" and "B" to "B" cables available.

DLP-245PB MODULE

The DLP-245PB module comprises a "B" end USB receptacle whose output is processed by an FTDI 245BM chip, processed in turn by a PIC16F877. To operate this module, the user needs no detailed knowledge of USB protocol itself. The module is mounted on a rectangular circuit board 58mm by 18mm, with a 40-pin d.i.l. (dual-in-line) plug to interface to user electronics.

A 40-pin ZIF (zero insertion force) socket mounted on stripboard was used to test the module (see photograph). To get started, pins 18, 19, and 20 on the ZIF socket were connected together (see Fig.1), to take power from the USB receptacle and apply it to the module electronics. All the GND pins were also commoned. Other connections are possible, but the above may well serve for all simple needs.

The DLP-245PB transfers data to and from the host computer at up to two megabits per second (2MB/s). Most of the port pins on the PIC16F877 are available for use. Port D, although available, is also used for data transfer between the PIC and the FTDI chip, and can only be accessed by the user in a tri-state bus configuration.

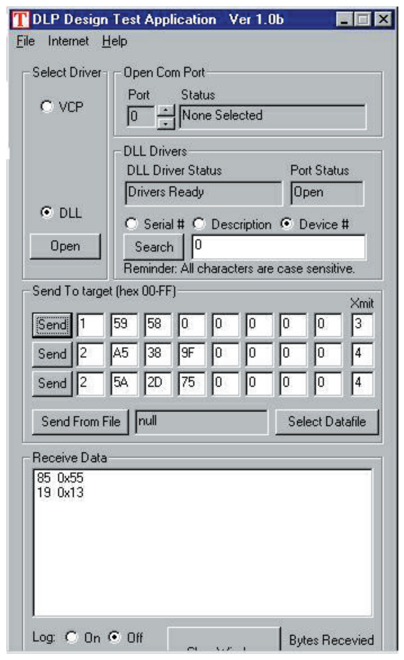
Of more likely interest to *EPE* readers are the remaining ports and pins available:

- Port A, together with Port E pin RE0, may be programmed from the host computer as all analogue, all digital, or mixed, in the usual way.
- Port B pin RB0 (which may be used as an interrupt), and pins 4 and 5.
- Port C in its entirety.
- An in-line programming header for the PIC16F877 that might be usable from the *EPE Toolkit TK3* programming facility.

The program in the PIC16F877, as delivered, allows access to the above port pins, both read and write. Data direction is

Table 2. Some Command Bytes with String Examples

Command byte	Action	Example string	Response
A5	Read a single port pin	2 A5 2B 8C reads RA3	55 bit
A6	Write to a single port pin	3 A6 2B 1 8F sets RA3 3 A6 2B 0 84 clears RA3	55 55
A8	Setup A/D	3 A8 89 81 A3 sets all six channels to analog; the third byte (89) sets ADCON1, see Table 4, and the fourth byte (81) sets ADCON0, see Table 3	55
A9	Convert A/D in designated channel	2 A9 2 A9 selects channel AN2 to convert	55 LSB MSB
55/59	Read Port A/C	1 59 58 reads port C	55 byte
56/5A	Write to Port A/C	2 59 2D 75 writes the byte 2D to port C	55



Example of the DLP Design Test Application screen.

Table 1. Port Pin Byte Assignments

Port pin	Port A	Port B	Port C	Port D	Port E
0	28	30	38	40	48
1	29	31	39	41	49
2	2A	32	3A	42	4A
3	2B	33	3B	43	4B
4	2C	34	3C	44	4C
5	2D	35	3D	45	4D
6	–	36	3E	46	4E
7	–	37	3F	47	4F

automatically set in each case; the user has no direct access to the TRISx registers anyway. The following actions may be invoked at the host computer:

- Any port pin may be set or cleared, or its status read. Although all port pins of the five registers Port A to Port E may be so accessed, trying to do so for other than the port pins mentioned above could produce unexpected results.
- The user may write a byte to or read a byte from any port register; again the caution just mentioned applies. Of course, this is a pseudo-parallel data transfer, as all operations are really serial.

SETTING UP

DLP Design provides access to drivers for the host computer. These drivers are provided royalty free, given they are used in conjunction with DLP modules. Also provided as a free download is test software for the host computer – see screen shot above right.

The drivers come in two forms: as a virtual COM port (VCP) or a dynamic-linked library (DLL). The DLL was used for the tests. There are several versions of each driver to suit Windows and Macintosh operating systems. In keeping with the user-friendly nature of USB, the DLP-245PB causes the host computer to search for a driver the first time it is plugged in.

The user navigates to the folder where the aforementioned drivers have been placed, and follows the Wizard's instructions. Thereafter, the drivers are loaded automatically each time the module is plugged in, unless a different driver is to be selected.

The test software sends a series of bytes to the DLP module. The bytes comprise:

- The first byte is the number of command bytes to follow.
- The next bytes are the command string, typically one to three bytes.
- The final byte is an exclusive-OR checksum of all preceding bytes; the checksum byte is not included in the byte count.

If the module confirms the checksum, it returns 55h, followed by any data bytes appropriate to the command. Mostly this is just one byte showing the status of a port or port pin specified in the command bytes. If the check sum is not confirmed the module returns AAh. Unless the module returns 55h, the result should be ignored and/or the problem investigated.

COMMAND BYTES

Each port pin in the PIC16F877 is assigned a unique byte, as shown in Table 1 (all bytes are hexadecimal).

A list of some command bytes is given in Table 2. There are more commands available, as given in the documentation, but the ones listed are of most general interest. Examples of byte strings are given against each command, together with the response which that string should evoke. As stated earlier, the first byte is the number of command bytes, and the last byte is the checksum.

All the example strings were tried, and gave the expected result. Note that the documentation example for command A9 is the same as that used in Table 2, except that the checksum value is given as A8. This value gives a checksum error; the value should be A9.

ANALOGUE-TO-DIGITAL

The module's on-board PIC16F877 provides user access to six of its eight 10-bit A/D (analogue-to-digital) channels (RE1 and RE2 are not accessible). Tables 3 and 4 show the bytes required to set Port A and RE0 to the desired configuration.

Table 3. Setting the ADCON0 Special Purpose Register

Byte	A/D conversion clock select	ADCON0 bits 7,6	ADCON0 bit 0
0	A/D module shut off	XX	0
1	Fosc/2	00	1
41h	Fosc/8	01	1
81h	Fosc/32	10	1
C1h	Internal A/D RC oscillator	11	1

Table 4. Setting the ADCON1 Special Purpose Register (PCFG is the lower 4 bits of the register)

Byte (h)	AN5/RE0	AN4/RA5	AN3/RA3	AN2/RA2	AN1/RA1	AN0/RA0	Vref+	Vref–	PCFG
82	D	A	A	A	A	A	Vdd	Vss	0010
83	D	A	Vref+	A	A	A	AN3	Vss	0011
84	D	D	A	D	A	A	Vdd	Vss	0100
85	D	D	Vref+	D	A	A	AN3	Vss	0101
86	D	D	D	D	D	D	–	–	011x
89	A	A	A	A	A	A	Vdd	Vss	1001
8A	A	A	Vref+	A	A	A	AN3	Vss	1010
8B	A	A	Vref+	Vref–	A	A	AN3	AN2	1011
8C	D	A	Vref+	Vref–	A	A	AN3	AN2	1100
8D	D	D	Vref+	Vref–	A	A	AN3	AN2	1101
8E	D	D	D	D	D	A	Vdd	Vss	1110
8F	D	D	Vref+	Vref–	D	A	AN3	AN2	1111

Note that there are only 12 options available for ADCON1, compared to the 15 available with the full eight A/D channels.

TEST APPLICATION

If the DLL option is used, the **DLL** button (see screen shot) should be selected. The **DLL Driver Status** should show **Drivers Ready**, provided they have been loaded as already described. The **Open** button is clicked so that **Port Status** shows **Open**.

Bytes to be sent are entered in the boxes in the matrix (up to eight bytes), with the ninth box set to the total number of bytes to be sent. For example, to do the "read a single port pin" action (Table 2) enter "2 A5 2B 8C 0 0 0 0 4" in any line of the matrix, and press **Send**.

The response should appear in the **Receive Data** window as "85 0x55" (checksum correct) and "0 0x00" on successive lines if the port pin is low, or "1 0x01" if the port pin is high. Remember this would require RA3 to be selected as a digital input; see Table 4.

USING THE DLP-245PB

The module is driven by a series of bytes from the host computer, through a VCP or DLL. The bytes can originate in any programming environment, such as Visual Basic. Where appropriate, the module returns data bytes to the host computer. It is suggested that there are three main ways to use the module (disregarding use in a tri-state bus environment):

1. The module, with the supplied on-board PIC software, is used to interface directly with sensor or similar circuits. For this use there are six port pins, any of which may be analogue or digital, and two of these pins may be voltage references.

In addition, there are eleven digital port pins, including a complete 8-bit port (C), and the external interrupt pin RB0/INT. For example, the six A/D channels could monitor temperatures.

2. The on-board PIC's software can be modified for some special requirements, but limited by the number of port pins (not the full PIC16F877 set) available to the user, as just mentioned. DLP provide, as a separate item, a flash programmer, although the header for this programmer contains the same pins used by *TK3*. Of course, all the supplied USB interface code must be preserved.

3. The on-board PIC software remains as delivered, and the available port pins are used to interface with a user PIC. In effect, the user sets up Visual Basic (say) and PIC software so that the host computer and the user PIC have a well defined interface between them, which, having been established, becomes invisible to the user.

RESOURCES

See **www.dlpdesign.com/usb/245pb.html** for more information about the DLP-245PB module, especially where to obtain drivers, host computer test software and a circuit schematic. Enquiries may be directed to Don Powrie, **don@dlpdesign.com**, whom readers will find most helpful.

The author purchased the DLP-245PB module from Mouser Electronics in the USA, **www.mouser.com**, at $US85 not including tax or shipping. The UK price is currently £51.50, and the UK point of sale is Rae at FTDI in Scotland, **admin@ftdichip.com**. A special ordering web site for *EPE* readers has been set up by FTDI at **www.ftdichip.com/epe.htm**.

FTDI may also be contacted at: Future Technology Devices International Ltd., 373 Scotland Street, Glasgow G5 8QB. Tel: 0141 429 2777. Fax: 0141 429 2758. □

SHOP TALK
with David Barrington

EPE Experimental Seismograph Logger – 1

Our major project this month is the *Experimental Seismograph Logger* and nearly all the "special" parts used in the prototype were sourced from **RS Components**. They can be ordered through any *bona-fide* RS stockist or you can order direct (*credit card only*) from them on ☎ ***01536 444079*** or ***rswww.com***. A post and handling fee will be added to any order.

The Honeywell SS495A Hall-effect sensor came from RS and is coded 216-6231. They also supplied the LMC6484 quad, rail-to-rail, op.amp (code 310-925) and the "sensor" magnet, code 260-369.

Unfortunately, the magnet is only sold in batches of five which does add to the cost. However, the magnet type is not critical and probably any disc or bar type should suffice, even those used for fridge decoration/notes.

We only found one listing for Microchip's 24LC256 EEPROM memory chip and that was **Farnell** (☎ ***0870 1200 200*** or ***www.farnellinone.co.uk***), code 300-1696. The MAX232 RS232 serial driver interface i.c. should be generally available.

Quite a number of our advertisers stock 2-line 16-characters per line alphanumeric l.c.d. modules and sourcing should not be a problem. However, if you intend to use this optional device, you should check you have the relevant pinout information when purchasing so that you are able to "hardwire" it to the p.c.b. Non-polarised capacitors are now widely stocked and cost only a little more than electrolytics.

For those readers unable to program their own PICs, a preprogrammed PIC16F876 microcontroller can be purchased from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta2000.co.uk***) for the inclusive price of £10 each (overseas add £1 p&p). The software is available on its own 3·5in. PC-compatible disk from the *EPE* Editorial Office for the sum of £3 each (UK), too cover admin costs (for overseas charges see page 286). It is also available *Free* via the Downloads click-link option on the *EPE* home page when you enter our main web site at **www.epemag. wimborne.co.uk**, then enter the PIC Microcontroller source codes folder and select **Seismograph**.

The two Seismograph printed circuit boards are available as a pair from the *EPE PCB Service*, codes 440 (control) and 441 (sensor) – see page 286. The pendulum "plumbing" materials should be stocked by your local DIY superstore.

Infra-Guard Monitor

Apart from the pyroelectric sensor, most of the components for the *Infra-Guard Monitor* project should be freely available from our components advertisers and local stockists. The piezoelectric d.c. buzzer must be the type with an internal drive circuit and should, ideally, be rated at 10mA maximum current at 12V d.c. operation. The one in the model came from Maplin (☎ ***0870 264 6000*** or ***www.maplin.co.uk***), code KU56L.

We have been given two types and suppliers for the dual-element pyroelectric infra-red sensor. Looking much like a TO18 metal-cased transistor with an infra-red "receiving window" in its top surface, the Murata IRA-E700STO used in the prototype came from **Farnell** (☎ ***0870 1200 200*** or ***www.farnellinone.co.uk***), code 731-950. A similar device is the E600STO listed by Maplin (see above) as code UR69A.

The printed circuit board is available from the *EPE PCB Service*, code 439 (see page 286).

PIC Moon Clock

Constructors should have no difficulty in purchasing the components needed to build the *Moon Clock* project. A good quality "non-polarised" capacitor (C3) is needed for setting the PIC's clock oscillator.

You are more likely to be offered a 12 or 18-turn, top adjust, cermet preset potentiometer than the 10-turn specified in the comp. listing – this is OK. The Set/Run switch must be a momentary "push-to-break" push-button type.

The PIC microcontroller used by the author in this project is the PIC16C54-**RC** type. If you are programming your own you must set your programmer for an RC type, and the watchdog timer needs to be turned off.

A preprogrammed PIC can be purchased from **Magenta Electronics** (☎ ***01283 565435*** or ***www.magenta2000.co.uk***) for the inclusive price of £5.90 each (overseas add £1 p&p). Note that you may be supplied with a PIC16F84 or PIC16F627. The software is available on a 3·5in. PC-compatible disk (Disk 7) from the *EPE Editorial Office* for the sum of £3 each (UK), to cover admin costs (for overseas charges see page 286). It is also available *Free* via the Downloads click-link option on the EPE home page when you enter our main web site at **www.epemag.wimborne.co.uk**, then enter the PIC Microcontroller source codes folder and select **PIC MoonClock**.

The printed circuit board is available from the *EPE PCB Service*, code 442 (see page 286).

Loft Light Alarm

None of the components for the *Loft Light Alarm* project are critical and all should be "off-the-shelf" items available from our components advertisers. The author indicates that virtually any high gain (100+) small signal *npn* transistor will work in this circuit.

The preferred alarm sounder is a small piezoelectric buzzer which can usually operate from a 3V to 24V supply. Make sure you purchase one with an internal oscillator which only requires connecting to a d.c. supply to operate.

PLEASE TAKE NOTE

Jazzy Necklace *(Feb '04)*

The brass rod listed in the Components box (page 118) and copy (page 119) should read 1·2mm (3/64in.) dia. and not as indicated.

PIC Mixer for RC Planes *(Mar '04)*

The author has fixed a minor bug in the battery level detection software routine. His revised code has been put on our Downloads site, plus a note about it.

Car Computer *(Jan '04)*

A revised version of the software has been placed on our Downloads site. It corrects a minor display bug.

INFRA-GUARD MONITOR

TERRY de VAUX-BALBIRNIE

In-car protection for young children

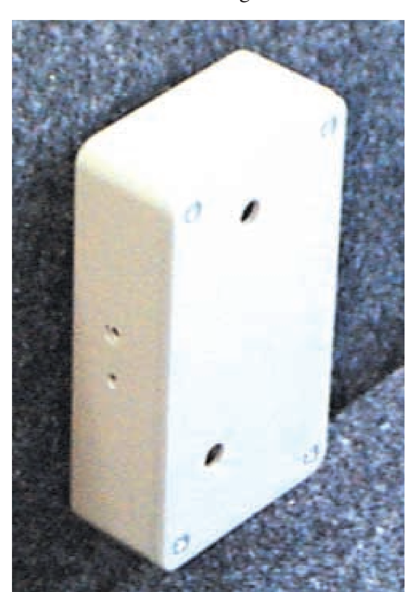
A READER now living in the USA wrote to *EPE* asking if we had ever published a design for a circuit he had in mind. His idea was for a device that would warn him if his small child had crawled to the rear of the car and into the area of the tailgate.

Children creep into any area that seems interesting to them and this can lead them into danger. A busy parent removing shopping from the car could become distracted and the child could fall out. Probably worse, if he or she should crawl with head, hands or feet partly outside an open door, closing it would cause severe injury.

PASSIVE SOLUTION

We had to say that we had not published a design for this purpose. However, it struck the author that this was such a good idea that it would be worth pursuing.

The circuit finally chosen and described here uses a *passive infra-red* solution. The unit is housed in a small plastic box placed so that it can "see" along the line that the child must not cross. If he or she does so, an internal buzzer will sound.



Infra-Guard mounted in the rear of the car. Note the sensor "window" and sound holes in the case lid.

The system will operate over a distance of over two metres so it should be suitable for all normal cars. It is powered from the existing 12V system and, on stand-by, draws less than 4mA. Although this current will be flowing continuously (see later), it imposes only a small drain on a well-charged battery. However, due to this, the circuit is ***not*** suitable for use with "ordinary" (*non-rechargeable*) batteries.

ELECTROMAGNETIC RADIATION

Infra-red is the type of electromagnetic radiation that lies between *microwaves* (having a greater wavelength) and *visible light* (having a shorter one). The range of wavelengths within the infra-red spectrum is very wide – from some 0·7μm to 1mm. Infra-red radiation is naturally emitted by warm objects and at normal human body temperature, the wavelength peaks at some 10μm.

> **IMPORTANT**
>
> ***This circuit must only be used as "last ditch" protection. It should never be used to protect unsupervised children. Remember, it could fail or the child could possibly avoid triggering it.***

To detect infra-red at this wavelength, a special sensor is needed – a *pyroelectric* detector. Most people are familiar with passive infra-red (PIR) devices that operate burglar alarms and security lights. These use a Fresnel lens system to focus the incoming radiation on to the sensor. This provides a wide response angle and a large range.

Here, the technique used is similar but the circuit only needs to detect the child over a narrow angle and over a relatively short range. No lens is therefore required.

PYROTECHNICS

A pyroelectric sensor looks rather like a transistor – two pins are used for the power supply and one for the output (see Fig.1). On top there is a "window" through which the infra-red passes – see photographs.

Since the detector would also be sensitive to radiation outside the required band, a silicon filter is "built in". This is opaque to infra-red above and below the chosen limits. With the specified device, the passband is set between 5μm to 14μm.

In the simplest device, the working part is a single ceramic electrode. When exposed to infra-red radiation, this develops a small electric charge whose value depends on the intensity of the radiation. A small voltage therefore appears across it and this is buffered using an internal field effect transistor (f.e.t.).

CANCELLING OUT

It turns out that such a basic sensor would provide an output in response to various unwanted stimuli such as vibration and radio-frequency interference (r.f.i). It would also exhibit altered characteristics with changes in ambient temperature.

To avoid such effects, it is usual to incorporate more than one sensor element in the package. The specified unit is a *dual* device – that is, it contains two identical ceramic elements placed side-by-side. These are connected in series but with opposed polarity so that their outputs subtract.

This method has the advantage that vibration, r.f.i. or changes in ambient temperature are likely to affect both elements equally so their effects will cancel out. However, it also means that infra-red reaching both elements equally will provide no output.

This is not a disadvantage when detecting a *moving* object because, as it travels across the field of "view", it will stimulate one element before the other one. The "full" output voltage will then appear, first in one direction and then the other.

DISCRIMINATION

Note that if the sensor were placed so that the elements were one above the other, the device would be insensitive to horizontal motion. Here, it will be oriented so that the elements are set at approximately 45 degrees with respect to an edge of the case. It therefore behaves well whether the box is eventually mounted vertically or horizontally.

The output signal has a peak value in the region of 5mV only. This needs considerable amplification to be useful. Random signals will also exist as background noise.

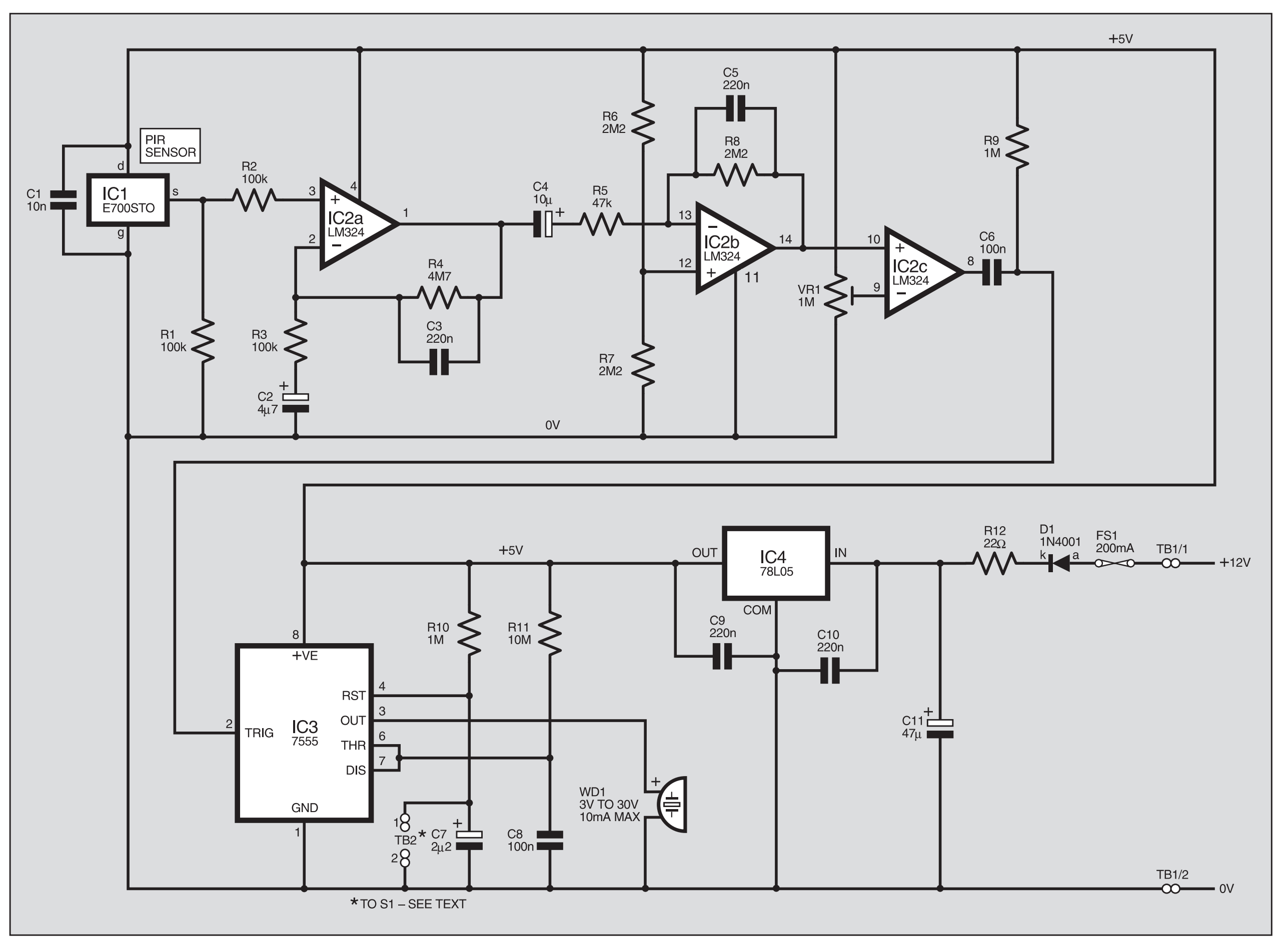


Fig.1. Complete circuit diagram for the in-car Infra-Guard Monitor.

The control circuit therefore needs to discriminate between low-level noise and the required output signal.

Note that *direct* sunlight should not reach the sensor during the course of use because the infra-red content of the radiation would "swamp" it and result in false operation.

CIRCUIT DETAILS

The full circuit diagram for the Infra-Guard Monitor is shown in Fig.1. Current enters the circuit through fuse FS1, diode D1 and fixed resistor R12. The diode provides reverse-polarity protection so that the semiconductors will not be damaged if the supply were to be connected in the wrong sense.

Resistor R12 limits the "inrush" current (which charges capacitor C11) at the instant of switching on which could otherwise cause damage. The "normal" current develops only a very small voltage across this resistor so it has virtually no effect during operation. Capacitor C11 provides smoothing and conditions the supply when the car engine is running.

A 5V linear voltage regulator, IC4, provides a stable supply for the circuit. This is needed because correct operation depends on the applied voltage. The regulator operates in conjunction with capacitors C10 and C9 connected between the input and output pins and 0V respectively.

STABILITY

The "d" and "g" pins of the pyroelectric sensor IC1 are connected to the positive (+5V) and 0V supply rails respectively. Capacitor C1 connected across the supply provides stability. The output appears at the "s" pin and current flows through load resistor R1.

Sensor IC1's output is connected to the non-inverting input (pin 3) of IC2a, a non-inverting a.c. amplifier, via input resistor R2. The gain is determined by the value of resistors R3 (a.c. coupled to 0V by capacitor C2) and R4 connected in parallel with capacitor C3 between the output (pin 1) and inverting input (pin 2).

The gain is made frequency-dependent by the presence of capacitor C3 in the feedback loop (and much less so by C2 connected in series with resistor R3 due to its relatively high value). The reactance of a capacitor falls with increasing frequency and so reduces the overall impedance of the R4/C3 parallel arrangement.

Without becoming bogged down by maths, calculation shows that the gain of this section is in the region of 7 times at 1Hz falling to unity as the frequency increases. In practice, a *slowly-moving* object will provide the gain of 7 times.

When a *slowly-moving* object is detected by sensor IC1, IC2a pin 1 will provide an output of 35mV approximately. However, any rapidly changing effects and high-frequency random noise will provide a much smaller output.

INVERTING AMPLIFIER

The signal derived from IC2a pin 1 is applied to the inverting amplifier IC2b through d.c. blocking capacitor C4 and input resistor R5. The non-inverting input (pin 12) voltage is set at one-half that of the supply (2·5V) due to the potential divider action of equal-value resistors R6 and R7.

This allows the amplified signal appearing at IC2b's output (pin 14) to rise and fall about this level. Without it, the inverting amplifier could not work because signals would need to fall below 0V and with a single supply as used here, this would be impossible.

Taking into account the reactance of capacitor C5 in the feedback loop, the gain of this section is some –13 times at 1Hz falling to almost zero at high frequencies (with a negative sign because it is an inverting amplifier). This virtually removes the effect of any high frequency noise.

The overall gain is found by multiplying together the gain of each stage giving (–)100 times approximately for a slowly-moving object. A 5mV change at the sensor input will, therefore, result in a change of almost 0·5V at the output. However, due to the inverting effect, it will result in a fall of this value from the base 2·5V giving some 2V.

COMPARATOR

The inverting input (pin 9) of voltage comparator IC2c is set at some voltage between the supply limits of 0V and 5V as determined by the adjustment of preset potentiometer VR1.

Suppose that it is set at 2·4V. Normally (that is, with no infra-red detected) the voltage at the non-inverting input (pin 10) will be 2·5V. Since the non-inverting input voltage exceeds the inverting one, IC2c output (pin 8) will be high and have no further effect. When a moving object is detected,

the voltage at pin 10 will "dip" momentarily below the 2·4V level at pin 9. With the input conditions reversed, IC2c output will go low.

This low state is transferred, via capacitor C6, to the trigger input of IC3 at pin 2. This is a CMOS 7555 timer i.c. configured as a monostable.

When IC3 is triggered by the low pulse, the output (pin 3) will go high for a time determined by the values of resistor R11 and capacitor C8. Those shown in the circuit diagram will give approximately one second. The audible warning device, WD1, (buzzer) connected to the output will then sound.

The time period could be increased by raising the value of R11 and vice versa. Resistor R9 maintains IC3 trigger input in a normally high condition which prevents false triggering.

The series arrangement of resistor R10 and capacitor C7 is connected to IC3's Reset input at pin 4. On powering-up, C7 will hold pin 4 low for a short time until it has charged sufficiently through R10. This keeps the i.c. inactive for a short time and prevents false operation which might occur otherwise.

TIME FACTOR

Terminal block TB2 may be used to connect an external "inhibit" door-operated switch (S1) to the circuit. While the car door is closed, the contacts will be "made" and apply a low state to IC3 pin 4. This will maintain the i.c. in a reset condition and hold off operation. Using such a switch would prevent possible triggering while the door is closed. More will be said about this later.

The reason why the circuit is powered continuously is that it takes the sensor some time (up to two minutes) to achieve correct operation after switching on. It would, therefore, not be satisfactory to power the circuit itself via a door-operated switch.

However, it would be possible to power it through a small dashboard-mounted switch connected in the positive supply feed. If the car was not used every day, it might be a good idea to fit one. Of course, it would be necessary to remember to switch on before each journey when a child was present.

CONSTRUCTION

IMPORTANT: ***This circuit must only be used as "last ditch" protection. It should never be used to protect unsupervised children. Remember, it could fail or the child could possibly avoid triggering it.***

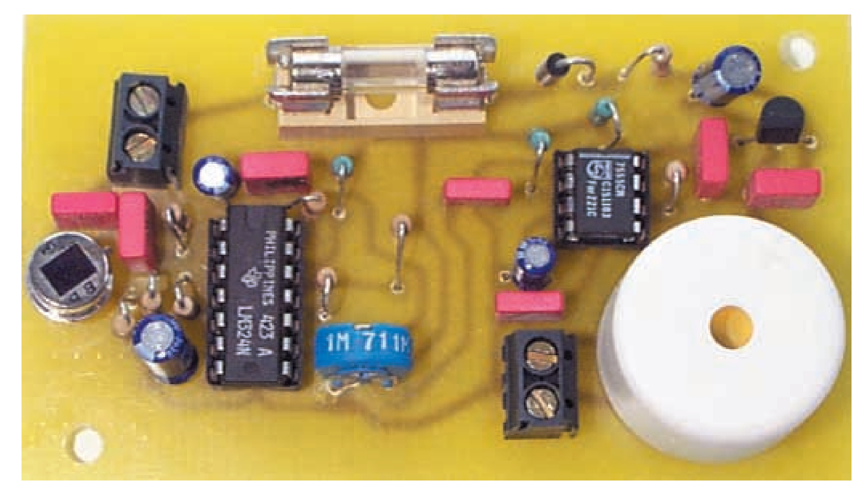
Construction of the Infra-Guard circuit is based on a single-sided printed circuit board (p.c.b.). This board is available from the *EPE PCB Service*, code 439. The component layout and actual size copper master pattern are shown in Fig.2.

Commence construction by first drilling the board mounting holes and solder the i.c. sockets, fuseholder FS1 and the two pieces of terminal block TB1 and TB2 in place. Follow with all resistors (including preset VR1) and capacitors taking care over the polarity of electrolytics C2, C4, C7 and C11.

Add the buzzer and regulator IC4 taking care over their orientation. The flat face of the regulator should be towards the buzzer.

Using minimum heat, solder the pyroelectric detector (IC1) in place, again, taking care over its orientation – the "d" (+V) pin is nearest to the tag. If you must shorten IC1 leads, do this only by the minimum amount needed. ***Do not apply the soldering iron for more than ten seconds per joint and allow each one to cool before another is made.*** **Neglecting these precautions could damage the device.**

Note that various dual-element pyroelectric sensors could be used in this circuit



Component layout on the completed printed circuit board. To save space, the resistors have been mounted vertically.

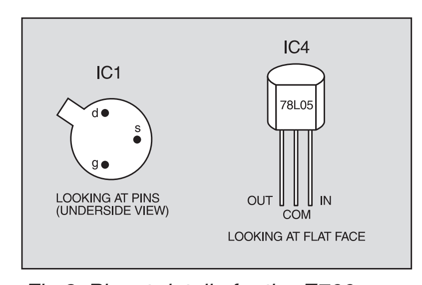


Fig.3. Pinout details for the E700 pyroelectric sensor (left) and the voltage regulator.

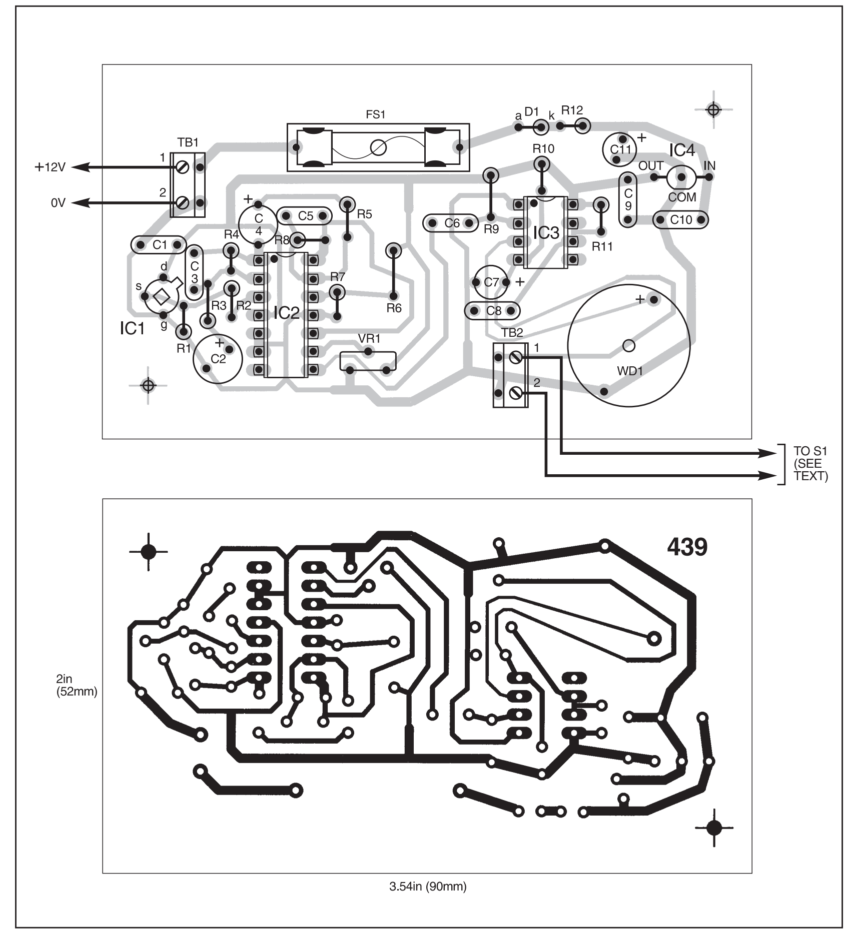


Fig.2. Printed circuit board topside component layout and full-size underside copper foil master.

(but these have not been tried in the model). However, if using one of these it will be necessary to check that the pinout is the same as the unit used in the prototype.

Adjust VR1 sliding contact to mid-track position then slightly anticlockwise (viewed from the lower edge of the p.c.b.). It will not be possible to adjust VR1 properly until the circuit panel has been mounted in the case. However, the setting above should give a good starting point.

TESTING

Commence the initial testing by inserting the fuse in the fuseholder. Connect a 9V supply (for example, 6 off AA size cells or a PP3 battery) to terminal block TB1 observing the polarity.

Remember, it takes up to two minutes for the sensor to become fully active so wait for at least this time keeping well away from it. Then move a hand across the field of view about one metre above it.

If the buzzer does not bleep, adjust VR1 slightly (probably a little more anticlockwise) and try again. Expect some false triggering because the sensor "sees" sources of infra-red over a very wide angle – regard this as a basic test only.

BOXING UP

Drill the holes in the base of the plastic box for the circuit board mounting. Attach it temporarily on short stand-off insulators or plastic washers to keep the soldered joints clear of the base.

Measure the position of the sensor and drill a hole in the lid directly above it – one having a diameter of 7mm was used in the prototype. Good results were obtained with the sensor "window" located between 15mm and 20mm below the hole. This narrows the angle of operation and improves the response of the unit. It also makes it much more difficult for direct sunlight to reach the sensor.

Measure the position of the buzzer and drill a hole in the lid directly above it for the sound to pass through. Mark the position on the side of the box directly in line with preset VR1. Mark positions also for the wires leading to terminal block TB1 and the doorswitch wires to TB2.

Remove the circuit panel and drill these holes. The hole above VR1 position should be made large enough to allow a trimming tool or small screwdriver to be used to adjust it.

Connect the temporary battery wires to TB1, also pieces of light-duty connecting wire to the "inhibit switch" terminals (TB2). Pass these wires through the holes drilled for the purpose. Fit the lid.

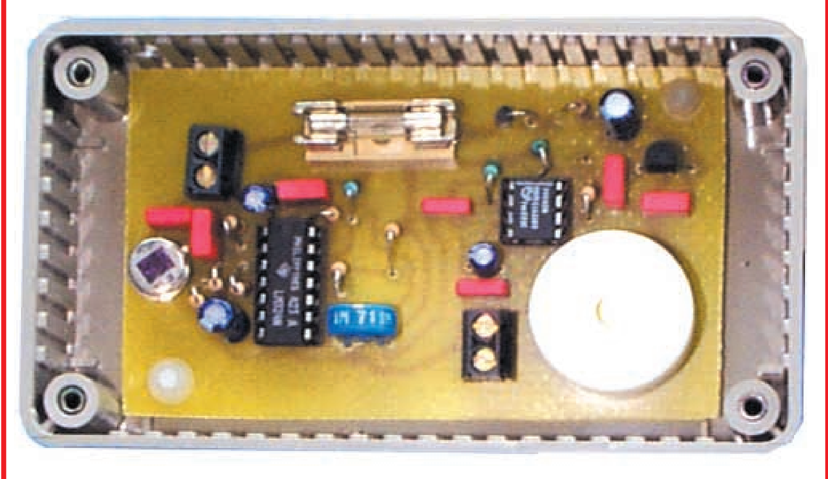
FINISHING OFF

Decide on a likely position for the unit in the car and check how it may be attached (a couple of self-adhesive Velcro pads would be ideal). Check that external wiring may be fed to it neatly. Make sure that direct sunlight cannot reach the sensor by directing it away from windows. Use the temporary (9V) supply until a final position has been found.

Connect the supply, wait for two minutes then check for correct operation. Use a thin screwdriver or trimming tool through the hole drilled for the purpose to adjust preset VR1 as required. The action of the door

COMPONENTS

Approx. Cost Guidance Only **£12** *excl. case*



The completed Infra-Guard circuit board mounted in the bottom of the case using nylon nuts and bolts. The board should also be raised on plastic stand-off spacers or washers to keep the soldered joints clear of the base.

See SHOP TALK page

Resistors

R1, R2, R3	100k (3 off)
R4	4M7
R5	47k
R6, R7, R8	2M2 (3 off)
R9, R10	1M (2 off)
R11	10M
R12	22Ω

All 0·25W 5% carbon film

Potentiometer

VR1	1M min. enclosed carbon preset, vertical

Capacitors

C1	10n polyester
C2	4μ7 radial elect., 16V
C3, C5, C9, C10	220n polyester (4 off)
C4	10μ radial elect. 10V
C6, C8	100n polyester (2 off)
C7	2μ2 radial elect. 16V
C11	47μ radial elect., 50V

Semiconductors

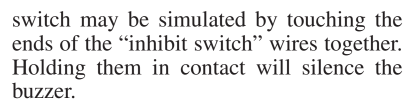
D1	1N4001 50V 1A rectifier diode
IC1	IRA-E700 dual-element pyroelectric sensor (or similar – see text)
IC2	LM324 quad op.amp
IC3	7555 low power timer
IC4	LM78L05ACZ 5V 100mA positive voltage regulator

Miscellaneous

FS1	200mA 20mm fuse and p.c.b. mounting fuseholder
WD1	d.c. buzzer 3V to 24V operation, 10mA maximum
TB1, TB2	2-way, p.c.b. mounting, screw terminal block – 5mm spacing (2 off)
S1	small switch (for example a microswitch) – see text

Printed circuit board available from the *EPE PCB Service*, code 439; plastic box size 112mm x 62mm x 31mm (external); 8-pin d.i.l. socket; 14-pin d.i.l. socket; auto-type connecting wire; nylon nuts and bolts; solder etc.





switch may be simulated by touching the ends of the "inhibit switch" wires together. Holding them in contact will silence the buzzer.

Before making the permanent power supply connections, you MUST disconnect the car battery. Using proper auto-type connectors, connect pieces of light-duty *auto-type* wire to TB1 terminals inside the box. Apply strain relief to the wires (for example using a tightly applied cable tie). Route the wires neatly and connect the +12V one to a point which is continuously "live" (+12V) *via an existing fuse* and the 0V wire to an earth point (car chassis).

For occasional or temporary use, it would be possible to connect the unit via the cigar lighter socket. If you decide to use this method, you *must* fit a line fuse (carrying a 1A fuse) close to the plug in the positive feed wire.

FINAL TRIALS

Make some trials under real conditions and decide whether the door-operated ("inhibit") switch S1 is needed. If there turns out to be false triggering during the course of driving (for example, due to "spikes" on the car charging circuit) it should be used. The switch (such as a small microswitch) should be attached using a small bracket. It should have contacts that close ("make") when the door is closed.

Note that an automotive "pin" switch (as used on a car door to switch the courtesy light on) is ***not*** suitable. This is because its contacts would be open when the door was closed.

If it is more convenient, connect one of the "inhibit" switch contacts to the car bodywork. Then only one switch wire is needed (connected to TB2/1). □

New Technology Update

Ian Poole checks out the different memory technologies that are leading the development pack at the moment.

MEMORY is a key element in many of today's electronic products. PCs are now typically supplied with around 500 megabytes of memory and often much more if they are to be able to satisfactorily perform their tasks with today's memory hungry applications. Memory usage is not confined to PCs. Any electronic equipment that uses processing will need memory and that means most modern pieces of electronic equipment.

Unfortunately there is no single type of "perfect" memory that fulfils all the memory requirements. In the past SRAM, DRAM, Flash, and many more types of memory have been used dependent upon the requirements.

Ferro-electric

It has been said that the science and technology of ferro-electric thin films is one of the fastest evolving fields of research world wide. This is being fuelled by the fact that they can be integrated into ferro-electric RAMs to provide non-volatile memory.

Although they offer very fast write speeds, the main drawback of these memories is their large cell size when compared to that of the familiar DRAM. Additionally there are manufacturing issues to be resolved, particularly with the platinum required in the electrodes for the ferro-electric capacitor.

Despite this, some reasonably large scale devices are now beginning to appear. One company recently launched a 128Kbit memory with a real time clock. With the reality of these chips, work is progressing apace and many of the issues should be overcome in time, making them a likely major player in the marketplace.

MRAM

The magneto-resistive RAM is another memory family that is starting to hit the market. It is claimed that MRAM could be a universal memory as it is able to provide a solution for many requirements.

Whatever the outcome, it certainly has a number of features that mean that it could be a very attractive option for many applications. The MRAM solution is non-volatile and can be used for applications where processor instructions are normally stored.

When compared to Flash memory it does not require the high programming voltage needed by Flash. Also, in applications where it is used in place of normal DRAM it does not require the periodic refresh cycle and this means that power consumption is considerably reduced – a major factor, especially for battery powered equipment such as mobile phones and laptop computers.

A further advantage of MRAM is that it readily interfaces with CMOS technologies and this not only reduces costs, because additional interface circuitry is not needed, but it also enables memory speeds to be increased and this can have a significant impact on the overall system speed.

Through The Tunnel

The MRAM technology is based upon a single transistor magnetic tunnel junction structure. The magnetic tunnel junction (MTJ) consists of a layer of insulating material between two electrodes of magnetic material. A current can travel or "tunnel" from one magnetic layer to the other through the insulator.

However, at the base of one electrode there is a fixed magnetic layer that creates a strong magnetic field to hold the magnetic polarisation of one of the magnetic layers in a particular direction. The other ferromagnetic layer is free to take up a magnetic polarisation in one of two ways.

It is found that when both ferromagnetic layers have the same polarisation then the overall cell has a low resistance and is said to be in its low resistance state. When the magnetic polarisations of the two layers are anti-parallel then the cell takes up a high resistance.

The cell is completed by the addition of a transistor to enable its read and write processes to be performed. It is possible to integrate the MTJ structure on top of the transistor and in this way create a low cost and compact cell structure. Additionally the cell does not have a limited life in terms of the number of read/write cycles it can perform, as in the case of Flash memory.

Currently Motorola has demonstrated a 4MB (256 × 16) memory based on its 0·18 micron five level metal process. Other industry giants including IBM and Infineon have independently developed their own MRAM technologies and Philips and STMicroelectronics have access to the technologies through industry partners.

Polymer Films

Another new idea that has potential, if a few breakthroughs can be made, is polymer film memory. Here a polymer film placed between two electrodes can be switched between two stable states.

This idea has been investigated by a number of organisations including Intel and Infineon, but problems with scaling have so far prevented it from becoming a viable alternative to the other front runners. Nevertheless, it shows the promise of providing a low cost method of manufacturing memory.

Flash

Despite the fact that Flash memory has been available for many years there is still much research work being undertaken. In one development researchers are scaling it to 65nm and possibly to a smaller process, although with these dimensions problems are expected with the floating gate structure.

While the technology is in widespread use because it is a convenient non-volatile technology it still has the drawbacks of a relatively slow write cycle and the need for a high programming voltage. It also has a finite life, although the number of write/erase cycles is up in the region of several hundreds of thousands nowadays and this is normally more than adequate for most applications. In view of its convenience it is ideal for many applications and the technology is in widespread use.

Summary

With memory playing such an important role in electronics technology these days, successful new developments are likely to reap rich rewards, and this is why so many companies are investing such vast sums of money into their development. Any company that could develop a memory technology that covered a number of different applications would certainly be on to a winner.

It would enable producers of electronic equipment to standardise far more than they can at the moment and as a result of this the sales of the memory technology would soar. Currently there are plenty of chip technologies jostling for the top position, but even now the "perfect" memory, able to fill all the various memory roles, does not appear to be amongst them.

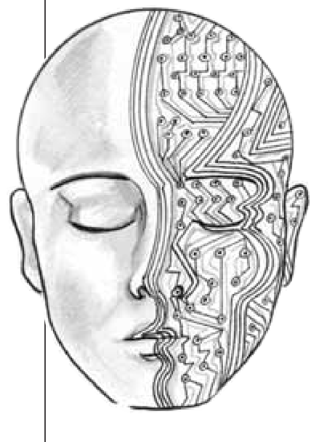
Farewell

Having run since 1992, this is the last of the regular *New Technology Update* reports. It has been a great pleasure writing about new technological developments from around the globe.

In the meantime, don't forget there is plenty of information at my website: **www.radio-electronics.com** and also at my new business website **www.adrio-communications.com**.

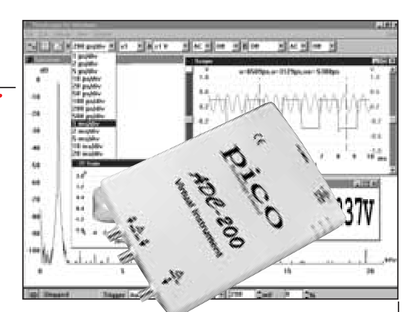
Thank you all for reading *Update* over the years – Ian.

Ian Poole is a freelance technical journalist and electronic engineering consultant at Adrio Communications.



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Simple Frequency Meter – Step-by-Step

ONE of the author's most useful tools is a Frequency Meter. Such meters tend to be costly, however, and in many instances an approximate reading of the frequency would suffice. The circuit diagram of Fig.1 shows a Simple Frequency Meter which will display 1kHz to 10kHz in 1kHz steps, and 10kHz to 100kHz in 10kHz steps by switching in capacitor C1 or C2.

Op.amp IC1a is wired as a relaxation oscillator. Its frequency may be calculated approximately by the formula f = 0·689 / (R3 × C1 or C2). However, this formula no longer applies at higher frequencies (the constant then needs to be raised).

Op.amp IC1b is wired as a simple preamplifier. One of its features is less often encountered, namely diode D2. This diode can be almost any germanium diode, which at smaller output amplitudes almost cancels out all feedback, thereby boosting gain.

Preamplifier IC1b clocks decade counter IC2, while IC1a resets it. Assuming that IC1b clocks IC2 at 1kHz (with S1 switched to C1), if IC1a resets IC2 at 1kHz or less, only D3 will be able to light up – no further clock pulses will be allowed to "break through". On the other hand, if IC1b clocks IC2 at, say, 5kHz, D3 to D7 will light up, since five pulses are able to "break through" before IC2 is reset by IC1a.

The supply voltage may range from 5V to 15V, and is not critical to accuracy, which will remain within about 2% at all times. Zener diode D1 should match the supply voltage, and protects IC1b's inverting input from over-voltages.

Only one ballast resistor (R8) is required for the l.e.d.s, since only one l.e.d will illuminate at a time. These should be ultrabright l.e.d.s, since they will mostly have a small duty cycle. The oscillator stage (IC1a) in particular should employ high grade, close tolerance components. The alternative is to replace resistor R3 with a preset potentiometer, and adjust the oscillator frequency with the aid of a frequency meter (1kHz for a 10kHz range, and 10kHz for a 100kHz range).

The Simple Frequency Meter has 100mV sensitivity, and may be used with input signals up to 50V. When measuring pulses greater than 12V the waveforms will simply be clipped by Zener diode D1.

If further amplifier stages were to be added after IC1b, the meter could be made exceedingly sensitive. However, the value of capacitor C3 would need to be reduced accordingly, to reduce the loading on the circuits being measured.

There are two caveats when measuring frequency with this circuit. Firstly, in the case of more sensitive circuits, loading on the circuit being measured may skew the frequency readings. Secondly, if the frequency being measured should contain marked harmonics, this may give a misleading reading.

If the frequency of IC1a is reduced to a few hundred Hertz, and the probes are connected to a radio or amplifier speaker, the meter may be used as a frequency-to-light display.

Thomas Scarborough, South Africa

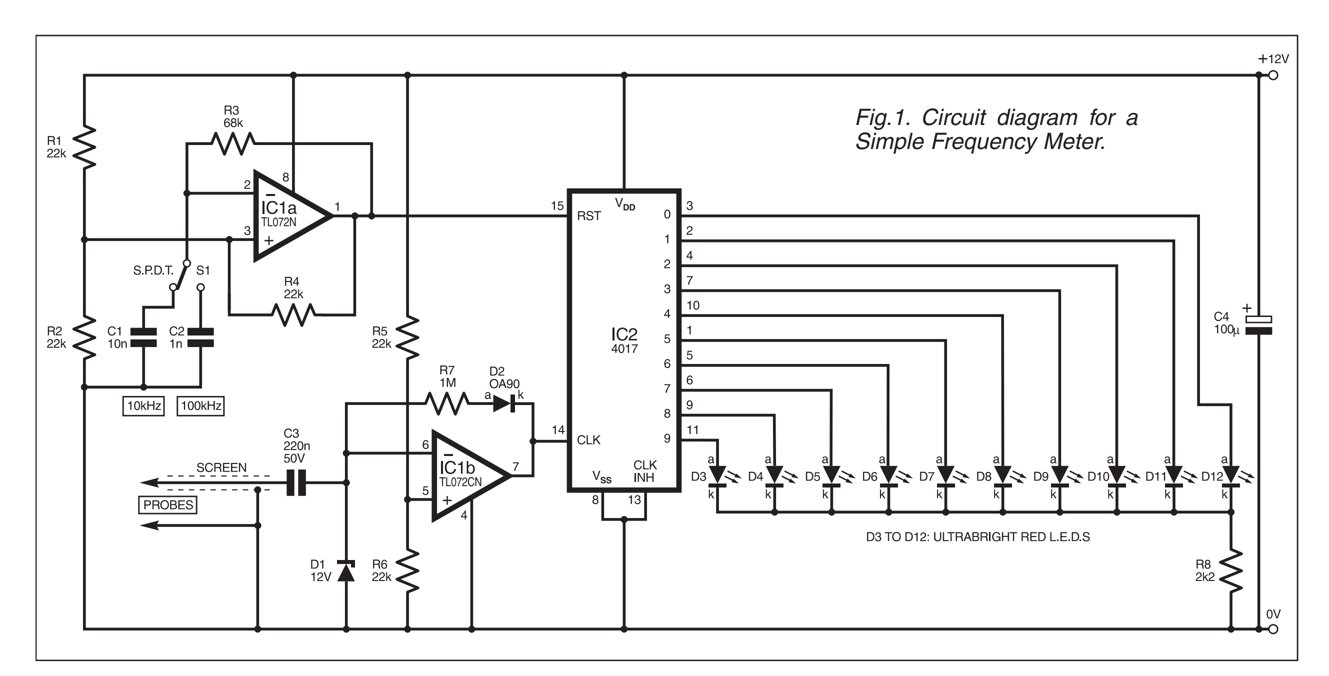


Fig.1. Circuit diagram for a Simple Frequency Meter.

Decade Power Supply – Switched-on Power

WHEN experimenting with circuits using discrete components there often arises the need for a small power supply unit (p.s.u.). It is also useful to be able to vary the output stage of such a p.s.u. provided each setting is stabilised. The final circuit presented here provides such facilities and was designed with the specific intention of holding, where possible, to the pattern of a decade resistance or capacitance box.

The method of controlling the output voltage is shown in the basic regulator circuit of Fig.2, where $V_{out} = 1{\cdot}25(1+R_x/R_y)$. Suppose the output of the regulator is increased from V1 to V2 by increasing R_x by a certain amount, call it R_z. Then $V2–V1 = 1{\cdot}25 \times R_z/R_y$. If the desired increment in voltage is 1V, $R_y = 1{\cdot}25 \times Rx$. Usually R_y is 200 ohms to 240 ohms.

A graph on which values of R_z are plotted against corresponding values of R_y, which give 1V increments, is shown in Fig.3. The graph shows that there are two points at which “preferred” values of resistor occur, viz. R_z = 160 ohms with R_y = 200 ohms and R_z = 180 ohms with R_y = 225 ohms. The second pair were used because 180 ohms is a more common value and anyway it was intended to have provision for adjustment of the output. Increments of 0·1V are obtained with R_z = 18 ohms and 10V with 1·8 kilohms resistors.

The final circuit diagram for the Decade Power Supply is shown in Fig.4 and uses the well known LM317T adjustable voltage regulator i.c. Components T1, REC1, C1 and C2 form a conventional full-wave bridge rectifier supply for voltage regulator IC1. Preset VR1 together with resistor R1 gives the required theoretical value of 225 ohms (R_y in Fig.2). The other resistance between the “adjust” terminal of IC1 and the 0V rail is provided by resistors R2, R3 and R4 plus the resistor network selected by rotary switches S3 and S4.

The **0.1V Decade** is provided by switch S4 and the **1V Decade** by S3. For the **10V** increment only switch S2 is used.Hence the output can be set to any value between 3V and 25V in steps of 0·1V.

It should be stressed that the rotary switches S3 and S4 **MUST** be ***make-before-break*** types for the following reason. If the resistor network between IC1 adjust pin and the 0V rail is allowed to go open circuit, the p.s.u. output will rise to a level approaching the regulator’s input with possible damage to the load. For this reason, the 12th position (tag) of rotary switch S4 ***must*** also be linked to the 11th position.

To set up the p.s.u. a voltmeter should be connected to the output terminals and the controls set as follows: S2 set to 0V (closed). Switch S3 set to 3V and S4 to 0V. Preset VR1 should then be adjusted to give 3V output. The intermediate settings of S2, S3 and S4 can then be tested.

All resistors should be standard 0·25W 1% metal film types and preset VR1 is a multiturn cermet, with end adjust. The prototype used a 12VA mains transformer, giving a maximum output of 600mA. If a larger output is needed, a higher rated transformer can be used up to 30VA to give 0·5A maximum; the limit of the LM317T. Care must also be exercised to make sure you use an adequate heatsink for the regulator i.c.

W. L. Alton,
Broadstone, Dorset

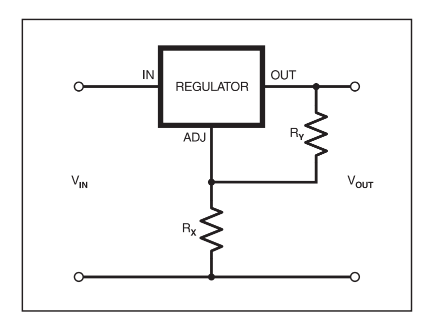


Fig.2. Basic regulator circuit.

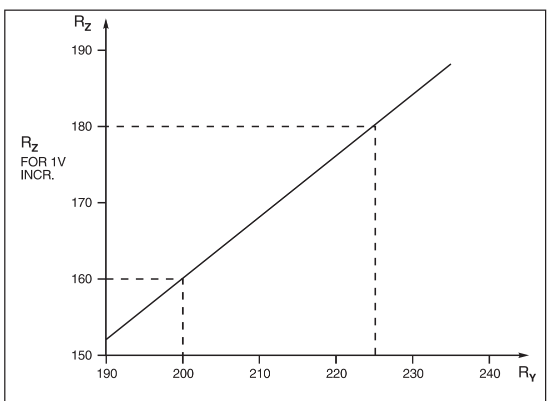


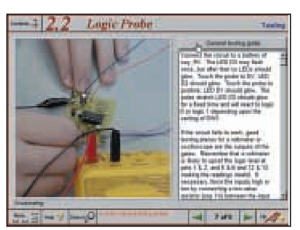
Fig.3. Graph showing R_z vs R_y to give 1V increments.

Fig.4. Circuit diagram for a Decade Power Supply.

EPE IS PLEASED TO BE ABLE TO OFFER YOU THESE

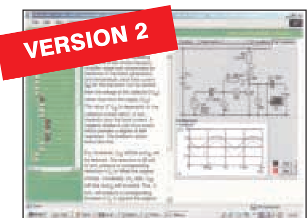
ELECTRONICS CD-ROMS

ELECTRONICS PROJECTS


Logic Probe testing

Electronic Projects is split into two main sections: **Building Electronic Projects** contains comprehensive information about the components, tools and techniques used in developing projects from initial concept through to final circuit board production. Extensive use is made of video presentations showing soldering and construction techniques. The second section contains a set of ten projects for students to build, ranging from simple sensor circuits through to power amplifiers. A shareware version of Matrix's CADPACK **schematic capture**, **circuit simulation** and **p.c.b. design** software is included.
The projects on the CD-ROM are: Logic Probe; Light, Heat and Moisture Sensor; NE555 Timer; Egg Timer; Dice Machine; Bike Alarm; Stereo Mixer; Power Amplifier; Sound Activated Switch; Reaction Tester. Full parts lists, schematics and p.c.b. layouts are included on the CD-ROM.

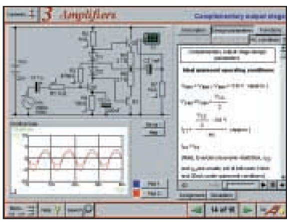
ELECTRONIC CIRCUITS & COMPONENTS V2.0



Circuit simulation screen

Provides an introduction to the principles and application of the most common types of electronic components and shows how they are used to form complete circuits. The virtual laboratories, worked examples and pre-designed circuits allow students to learn, experiment and check their understanding. Version 2 has been considerably expanded in almost every area following a review of major syllabuses (GCSE, GNVQ, A level and HNC). It also contains both European and American circuit symbols. Sections include: ***Fundamentals:*** units & multiples, electricity, electric circuits, alternating circuits. ***Passive Components:*** resistors, capacitors, inductors, transformers. ***Semiconductors:*** diodes, transistors, op.amps, logic gates. ***Passive Circuits. Active Circuits.*** *The Parts Gallery* will help students to recognise common electronic components and their corresponding symbols in circuit diagrams.
Included in the Institutional Versions are multiple choice questions, exam style questions, fault finding virtual laboratories and investigations/worksheets.

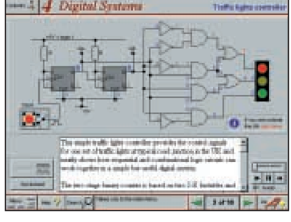
ANALOGUE ELECTRONICS


Complimentary output stage

Analogue Electronics is a complete learning resource for this most difficult branch of electronics. The CD-ROM includes a host of virtual laboratories, animations, diagrams, photographs and text as well as a SPICE electronic circuit simulator with over 50 pre-designed circuits.
Sections on the CD-ROM include: **Fundamentals** – Analogue Signals (5 sections),Transistors (4 sections), Waveshaping Circuits (6 sections). **Op.Amps** – 17 sections covering everything from Symbols and Signal Connections to Differentiators. **Amplifiers** – Single Stage Amplifiers (8 sections), Multi-stage Amplifiers (3 sections). **Filters** – Passive Filters (10 sections), Phase Shifting Networks (4 sections), Active Filters (6 sections). **Oscillators** – 6 sections from Positive Feedback to Crystal Oscillators. **Systems** – 12 sections from Audio Pre-Amplifiers to 8-Bit ADC plus a gallery showing representative p.c.b. photos.

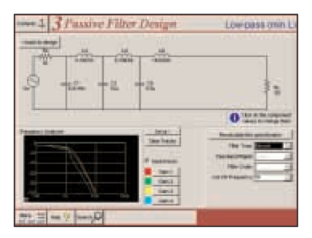
DIGITAL ELECTRONICS V2.0




Virtual laboratory – Traffic Lights

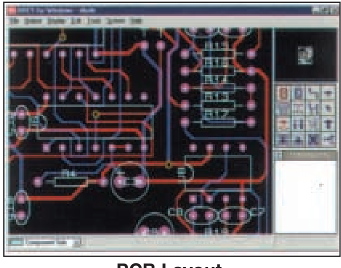
Digital Electronics builds on the knowledge of logic gates covered in *Electronic Circuits & Components* (opposite), and takes users through the subject of digital electronics up to the operation and architecture of microprocessors. The virtual laboratories allow users to operate many circuits on screen.
Covers binary and hexadecimal numbering systems, ASCII, basic logic gates, monostable action and circuits, and bistables – including JK and D-type flip-flops. Multiple gate circuits, equivalent logic functions and specialised logic functions. Introduces sequential logic including clocks and clock circuitry, counters, binary coded decimal and shift registers. A/D and D/A converters, traffic light controllers, memories and microprocessors – architecture, bus systems and their arithmetic logic units. Sections on Boolean Logic and Venn diagrams, displays and chip types have been expanded in Version 2 and new sections include shift registers, digital fault finding, programmable logic controllers, and microcontrollers and microprocessors. The Institutional versions now also include several types of assessment for supervisors, including worksheets, multiple choice tests, fault finding exercises and examination questions.

FILTERS


Filter synthesis

Filters is a complete course in designing active and passive filters that makes use of highly interactive virtual laboratories and simulations to explain how filters are designed. It is split into five chapters: **Revision** which provides underpinning knowledge required for those who need to design filters. **Filter Basics** which is a course in terminology and filter characterization, important classes of filter, filter order, filter impedance and impedance matching, and effects of different filter types. **Advanced Theory** which covers the use of filter tables, mathematics behind filter design, and an explanation of the design of active filters. **Passive Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev ladder filters. **Active Filter Design** which includes an expert system and filter synthesis tool for the design of low-pass, high-pass, band-pass, and band-stop Bessel, Butterworth and Chebyshev op.amp filters.

ELECTRONICS CAD PACK


PCB Layout

Electronics CADPACK allows users to design complex circuit schematics, to view circuit animations using a unique SPICE-based simulation tool, and to design printed circuit boards. CADPACK is made up of three separate software modules. (These are restricted versions of the full Labcenter software.) **ISIS Lite** which provides full schematic drawing features including full control of drawing appearance, automatic wire routing, and over 6,000 parts. **PROSPICE Lite** (integrated into ISIS Lite) which uses unique animation to show the operation of any circuit with mouse-operated switches, pots. etc. The animation is compiled using a full mixed mode SPICE simulator. **ARES Lite** PCB layout software allows professional quality PCBs to be designed and includes advanced features such as 16-layer boards, SMT components, and an autorouter operating on user generated Net Lists.

ROBOTICS & MECHATRONICS


Case study of the Milford Instruments Spider

Robotics and Mechatronics is designed to enable hobbyists/students with little previous experience of electronics to design and build electromechanical systems. The CD-ROM deals with all aspects of robotics from the control systems used, the transducers available, motors/actuators and the circuits to drive them. Case study material (including the NASA Mars Rover, the Milford Spider and the Furby) is used to show how practical robotic systems are designed. The result is a highly stimulating resource that will make learning, and building robotics and mechatronic systems easier. The Institutional versions have additional worksheets and multiple choice questions.

- Interactive Virtual Laboratories
- Little previous knowledge required
- Mathematics is kept to a minimum and all calculations are explained
- Clear circuit simulations

PRICES

Prices for each of the CD-ROMs above are:

(Order form on third page)

Hobbyist/Student ....£45 inc VAT
Institutional (Schools/HE/FE/Industry)..............£99 *plus* VAT
Institutional 10 user (Network Licence) ....£199 *plus* VAT
Site Licence..£499 *plus* VAT

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

PICmicro TUTORIALS AND PROGRAMMING

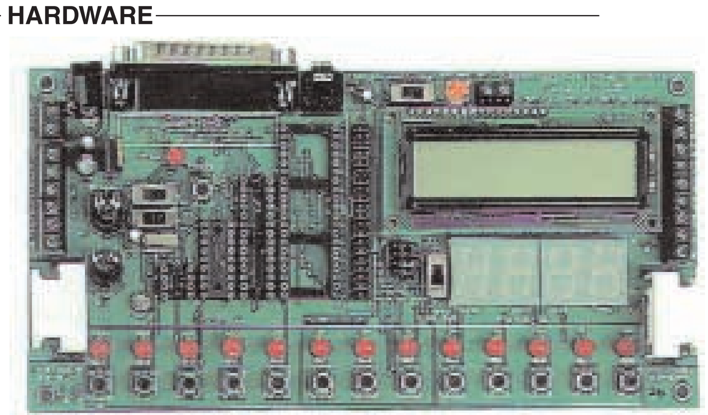
HARDWARE

VERSION 2 PICmicro MCU DEVELOPMENT BOARD

Suitable for use with the three software packages listed below.

This flexible development board allows students to learn both how to program PICmicro microcontrollers as well as program a range of 8, 18, 28 and 40-pin devices. For experienced programmers all programming software is included in the PPP utility that comes with the development board. For those who want to learn, choose one or all of the packages below to use with the Development Board.

- Makes it easier to develop PICmicro projects
- Supports low cost Flash-programmable PICmicro devices
- Fully featured integrated displays – 13 individual l.e.d.s, quad 7-segment display and alphanumeric l.c.d. display
- Supports PICmicro microcontrollers with A/D converters
- Fully protected expansion bus for project work
- All inputs and outputs available on screw terminal connectors for easy connection



£145 including VAT and postage

12V 500mA plug-top PSU (UK plug) £7

25-way 'D' type connecting cable £5

SOFTWARE

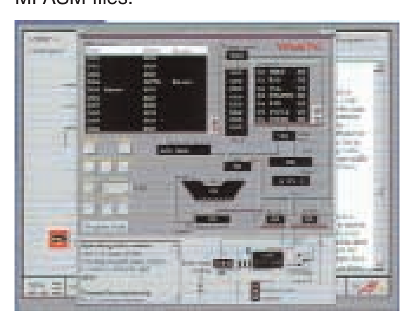
Suitable for use with the Development Board shown above.

ASSEMBLY FOR PICmicro V2

(Formerly PICtutor)

Assembly for PICmicro microcontrollers V2.0 (previously known as PICtutor) by John Becker contains a complete course in programming the PIC16F84 PICmicro microcontroller from Arizona Microchip. It starts with fundamental concepts and extends up to complex programs including watchdog timers, interrupts and sleep modes. The CD makes use of the latest simulation techniques which provide a superb tool for learning: the Virtual PICmicro micro-controller. This is a simulation tool that allows users to write and execute MPASM assembler code for the PIC16F84 microcontroller on-screen. Using this you can actually see what happens inside the PICmicro MCU as each instruction is executed which enhances understanding.

● Comprehensive instruction through 39 tutorial sections ● Includes Vlab, a Virtual PICmicro microcontroller: a fully functioning simulator ● Tests, exercises and projects covering a wide range of PICmicro MCU applications ● Includes MPLAB assembler ● Visual representation of a PICmicro showing architecture and functions ● Expert system for code entry helps first time users ● Shows data flow and fetch execute cycle and has challenges (washing machine, lift, crossroads etc.) ● Imports MPASM files.



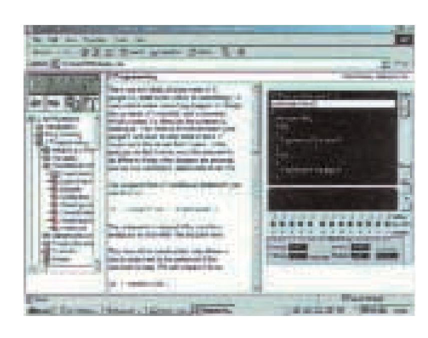
Virtual PICmicro

'C' FOR PICmicro VERSION 2

The C for PICmicro microcontrollers CD-ROM is designed for students and professionals who need to learn how to program embedded microcontrollers in C. The CD contains a course as well as all the software tools needed to create Hex code for a wide range of PICmicro devices – including a full C compiler for a wide range of PICmicro devices.

Although the course focuses on the use of the PICmicro microcontrollers, this CD-ROM will provide a good grounding in C programming for any microcontroller.

● Complete course in C as well as C programming for PICmicro microcontrollers ● Highly interactive course ● Virtual C PICmicro improves understanding ● Includes a C compiler for a wide range of PICmicro devices ● Includes full Integrated Development Environment ● Includes MPLAB software ● Compatible with most PICmicro programmers ● Includes a compiler for all the PICmicro devices.



Minimum system requirements for these items: Pentium PC running Windows 98, NT, 2000, ME, XP; CD-ROM drive; 64MB RAM; 10MB hard disk space.

FLOWCODE FOR PICmicro

Flowcode is a very high level language programming system for PICmicro microcontrollers based on flowcharts. Flowcode allows you to design and simulate complex robotics and control systems in a matter of minutes.

Flowcode is a powerful language that uses macros to facilitate the control of complex devices like 7-segment displays, motor controllers and l.c.d. displays. The use of macros allows you to control these electronic devices without getting bogged down in understanding the programming involved.

Flowcode produces MPASM code which is compatible with virtually all PICmicro programmers. When used in conjunction with the Version 2 development board this provides a seamless solution that allows you to program chips in minutes.

● Requires no programming experience ● Allows complex PICmicro applications to be designed quickly ● Uses international standard flow chart symbols (ISO5807) ● Full on-screen simulation allows debugging and speeds up the development process ● Facilitates learning via a full suite of demonstration tutorials ● Produces ASM code for a range of 8, 18, 28 and 40-pin devices ● Institutional versions include virtual systems (burglar alarms, car parks etc.).



Burglar Alarm Simulation

PRICES

Prices for each of the CD-ROMs above are:

(Order form on next page)

Hobbyist/Student	£45 inc VAT
Institutional (Schools/HE/FE/Industry)	£99 *plus* VAT
Flowcode Institutional	£70 *plus* VAT
Institutional 10 user (Network Licence)	£249 *plus* VAT
Site Licence	£599 *plus* VAT

(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

TEACH-IN 2000 – LEARN ELECTRONICS WITH EPE

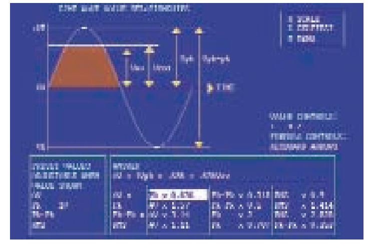
EPE's own *Teach-In* CD-ROM, contains the full 12-part *Teach-In* series by John Becker in PDF form plus the *Teach-In* interactive software (Win 95, 98, ME and above) covering all aspects of the series. We have also added Alan Winstanley's highly acclaimed *Basic Soldering Guide* which is fully illustrated and which also includes *Desoldering*. The *Teach-In* series covers: Colour Codes and Resistors, Capacitors, Potentiometers, Sensor Resistors, Ohm's Law, Diodes and L.E.D.s, Waveforms, Frequency and Time, Logic Gates, Binary and Hex Logic, Op.amps, Comparators, Mixers, Audio and Sensor Amplifiers, Transistors, Transformers and Rectifiers, Voltage Regulation, Integration, Differentiation, 7-segment Displays, L.C.D.s, Digital-to-Analogue.

Each part has an associated practical section and the series includes a simple PC interface (Win 95, 98, ME **ONLY**) so you can use your PC as a basic oscilloscope with the various circuits.

A hands-on approach to electronics with numerous breadboard circuits to try out.

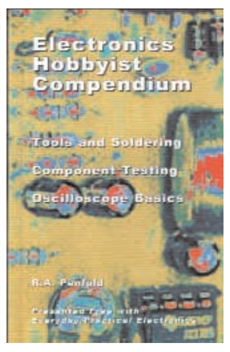
£12.45 including VAT and postage. Requires Adobe Acrobat (available free from the Internet – **www.adobe.com/acrobat**).

FREE WITH EACH TEACH-IN CD-ROM – *Electronics Hobbyist Compendium* 80-page book by Robert Penfold. Covers Tools For The Job; Component Testing; Oscilloscope Basics.



Sine wave relationship values

FREE BOOK WITH TEACH-IN 2000 CD-ROM



DIGITAL WORKS 3.0

Counter project

Digital Works Version 3.0 is a graphical design tool that enables you to construct digital logic circuits and analyze their behaviour. It is so simple to use that it will take you less than 10 minutes to make your first digital design. It is so powerful that you will never outgrow its capability • Software for simulating digital logic circuits • Create your own macros – highly scalable • Create your own circuits, components, and i.c.s • Easy-to-use digital interface • Animation brings circuits to life • Vast library of logic macros and 74 series i.c.s with data sheets • Powerful tool for designing and learning.

Hobbyist/Student £45 inc. VAT.
Institutional £99 *plus* VAT.
Institutional 10 user £199 *plus* VAT.
Site Licence £499 *plus* VAT.

ELECTRONICS IN CONTROL

Two colourful animated courses for students on one CD-ROM. These cover Key Stage 3 and GCSE syllabuses. **Key Stage 3:** A pictorial look at the Electronics section featuring animations and video clips. Provides an ideal introduction or revision guide, including multi-choice questions with feedback. **GCSE:** Aimed at the Electronics in many Design & Technology courses, it covers many sections of GCSE Electronics. Provides an ideal revision guide with Homework Questions on each chapter. Worked answers with an access code are provided on a special website.

Single User £29 inc. VAT. Multiple User £39 plus VAT
Student copies (available only with a multiple user copy) £6 plus VAT
(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

ELECTRONIC COMPONENTS PHOTOS

A high quality selection of over 200 JPG images of electronic components. This selection of high resolution photos can be used to enhance projects and presentations or to help with training and educational material. They are royalty free for use in commercial or personal printed projects, and can also be used royalty free in books, catalogues, magazine articles as well as worldwide web pages (subject to restrictions – see licence for full details).

Also contains a **FREE** 30-day evaluation of Paint Shop Pro 6 – Paint Shop Pro image editing tips and on-line help included!

Price £19.95 inc. VAT

MODULAR CIRCUIT DESIGN

VERSION 3

Contains a range of tried and tested analogue and digital circuit modules, together with the knowledge to use and interface them. Thus allowing anyone with a basic understanding of circuit symbols to design and build their own projects. Version 3 includes data and circuit modules for a range of popular PICs; includes PICAXE circuits, the system which enables a PIC to be programmed without a programmer, and without removing it from the circuit. Shows where to obtain free software downloads to enable BASIC programming.

Essential information for anyone undertaking GCSE or "A" level electronics or technology and for hobbyists who want to get to grips with project design. Over seventy different Input, Processor and Output modules are illustrated and fully described, together with detailed information on construction, fault finding and components, including circuit symbols, pinouts, power supplies, decoupling etc.

Single User £19.95 inc. VAT. Multiple User £34 *plus* VAT
(UK and EU customers add VAT at 17.5% to "plus VAT" prices)

Minimum system requirements for these CD-ROMs: Pentium PC, CD-ROM drive, 32MB RAM, 10MB hard disk space. Windows 95/98/NT/2000/ME/XP, mouse, sound card, web browser.

CD-ROM ORDER FORM

Please send me:

- ☐ **Electronic Projects**
- ☐ **Electronic Circuits & Components V2.0**
- ☐ **Analogue Electronics**
- ☐ **Digital Electronics V2.0**
- ☐ **Filters**
- ☐ **Electronics CAD Pack**
- ☐ **Robotics & Mechatronics**
- ☐ **Assembler for PICmicro**
- ☐ **'C' for PICmicro**
- ☐ **Flowcode for PICmicro**
- ☐ **Digital Works 3.0**

Version required:

- ☐ **Hobbyist/Student**
- ☐ **Institutional**
- ☐ **Institutional 10 user**
- ☐ **Site licence**

- ☐ **PICmicro Development Board (hardware)**
- ☐ **Development Board UK plugtop power supply**
- ☐ **Development Board 25-way connecting lead**

- ☐ **Teach-In 2000 + FREE BOOK**
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- ☐ **Electronics In Control – Single User**
- ☐ **Electronics In Control – Multiple User**
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- ☐ **Modular Circuit Design – Multiple User**

Note: The software on each version is the same, only the licence for use varies.

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Institutional, Multiple User and Deluxe Versions – overseas readers add £5 to the basic price of each order for airmail postage (**do not add VAT** unless you live in an EU (European Union) country, then add 17½% VAT or provide your official VAT registration number).

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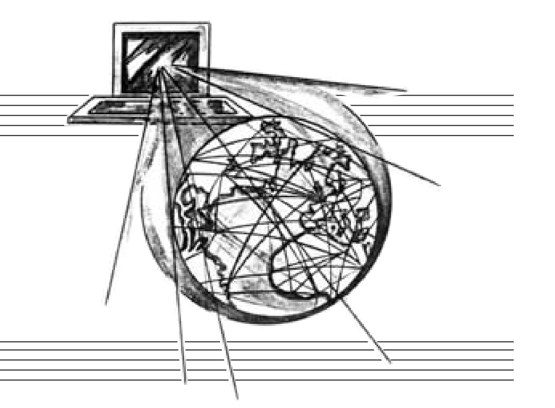
E-mail: orders@wimborne.co.uk

Online shop:
www.epemag.wimborne.co.uk/shopdoor.htm

SURFING THE INTERNET

NET WORK

ALAN WINSTANLEY



Track those Sites

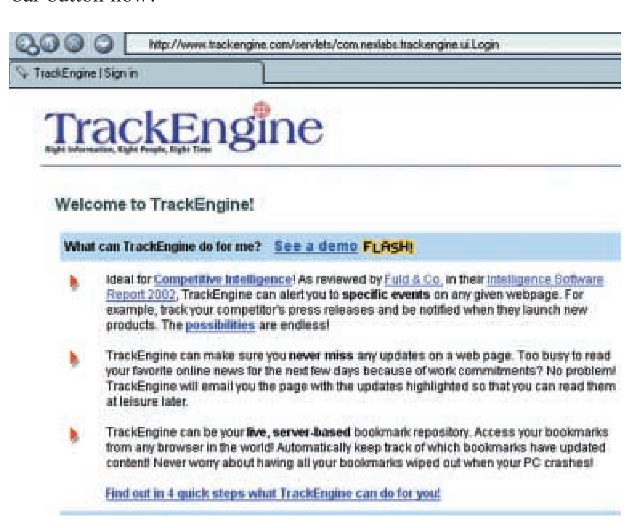
IN LAST month's *Net Work* column I highlighted the *EPE* Chat Zone message board (**www.epemag.wimborne.co.uk**), which enables readers to post questions or follow-ups, and generally make contact with like-minded electronics enthusiasts using a simple message forum system. Recently I have been trialling a useful service provided by Track Engine (**www.trackengine.com**) which, amongst other things, enables the outline contents of a forum to be sent to you by email.

This means that you can keep track of the message board without going to the trouble of firing up your web browser. It emails a snapshot of the forum messages which you can scan through at your leisure. Changed items are highlighted in colour.

Track Engine's regular emails will display the *EPE* Chat Zone and threads in Outlook Express, just like seeing the real thing. In order to read a message, simply go online, click the link (just as you would within the live Chat Zone) and the article will be fetched from our web server.

The service also provides a "Track This" tool button in your web browser, and this highlights another major feature of the service: not only does it work with the Chat Zone, but it can alert you when *any* web site has changed. Simply drag and drop their button onto your MSIE toolbar, and click it whenever you surf to the URL of a web site that you would like to track.

Regular users of our web site might like to try the service to advise when the downloads page has been updated for the latest PIC source codes. Bounce over to Track Engine and download that toolbar button now!



TrackEngine alerts users when web pages have been updated.

Pop Gun

If you are anything like the writer, you are probably fed up with pop-up windows that appear with boring regularity in a large number of sites. It is possible for web designers to program them to open either when users arrive at or depart from a web page.

Pop-ups are a lot more irritating than banner adverts; many web users mentally block out banner ads altogether, so they are nothing more than a trivial irritation. However, most pop-ups require the user to dismiss them with a mouse click. It has been reported that the next version of Microsoft Internet Explorer, due later this year, will have a pop-up blocker, but if you can't wait that long then a number of free tools are available including the Google toolbar which has a pop-up blocker, as does the Dogpile search toolbar, both worth checking out.

However, the technology behind pop-ups is also often used as an integral part of a web site's functionality. HSBC Online Banking, for example, is a faultless state of the art Internet front-end that allows direct access to business bank accounts, savings accounts and pension details. Like many sites, it uses pop-up technology to spawn new windows.

A recent problem with the author's Windows PC resulted in the highly infuriating problem of pop-ups being blocked – even when they were needed! Pressing the CTRL button and clicking is the usual way of allowing pop-ups to open. There was no reason at all why the browser should block pop-ups in this way, and much hair-pulling and head-scratching was necessary before the problem was resolved.

It was due to a single **.dll** file related to a previous trial of the pop-up blocker Winsettings 7.0 (**www.filestream.com**) not having been de-installed properly. Located in isolation in its own redundant folder, the errant **.dll** file caused MSIE to block pop-ups: deleting it manually finally solved the problem. Happily, later tests of Winsettings did de-install cleanly.

More Accessible – Less Arty

In actual fact, the use of pop-up windows is often a functionality preference of web designers (and we use them ourselves on the *EPE* web site). Using Javascript (or by letting Macromedia Dreamweaver do it automatically for you), designers can launch pop-ups galore, apply rollover buttons and add all manner of navigational aids.

For many UK web sites that use fancy trickery, horrendous colour schemes, miniscule lettering that needs an electron microscope to read, or contains tiny buttons or links, interesting times are ahead. The Disability Discrimination Act (DDA) will require that web sites be made a whole lot more accommodating for those having any form of sight disability, which might include colour blindness or sight impairment. Blind users, who use text-to-speech software to read out the contents of the web site, will have to be catered for much better than they are today, perhaps with a text-only version of the site.

Impossible colour schemes and very small buttons will be ruled out. Since the technology is already there to cater for such disabilities, what will be needed is a lot more consideration by web designers and a lot less self-indulgent design.

The world authority that is rolling out a "web accessibility initiative" is the World Wide Web Consortium (W3C) at **http://www.w3.org/WAI/** and it is there that web site designers will find the background guidance they need, assuming they can wade through the less than entirely "accessible" treacle-like bureaucracy and jargon of the W3C site. If UK-based web sites think they can sweep this under the carpet, it is worth remembering that visually impaired users are already participating in trials of hundreds of web sites, and it is only a matter of time before laws are laid down about what a web site can and cannot do

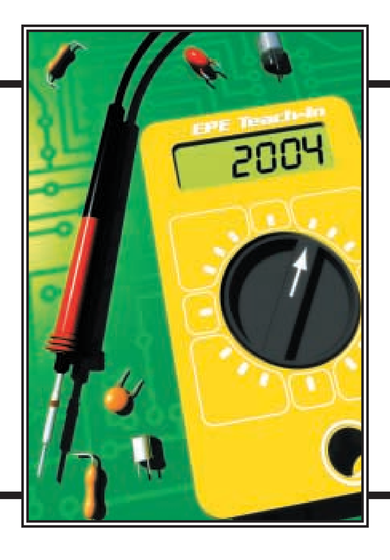
Accessibility will become the web buzzword of the future. A useful online tool for web designers is the popular *Bobby* service at **www.watchfire.com** but it is considered to be only one step in making a web site fully accessible. Watch for the Bobby button appearing on more and more web sites in the future, bringing with it the pressure to force websites to become less arty and more accessible.

Bobby accessibility logo.

You can contact the author at **alan@epemag.demon.co.uk**.

TEACH-IN 2004

Part Six – Sound Level Measurement



MAX HORSEY

How to apply electronics meaningfully – the aim of this 10-part series is to show, experimentally, how electronic components function as part of circuits and systems, demonstrating how each part of a circuit can be understood and tested, and offering advice about choosing components

AUTOMATIC recording level control used to be a nightmare! During quiet passages the sound level would be boosted – raising the background noise – and destroying the atmosphere of the music. The automatic control systems fitted to modern equipment seem to be much better in this respect.

If you record from the TV or radio, the sound levels will be carefully controlled by the broadcasters, and the dynamic range (explained later) will be reduced as needed. Hence, if you only record in this way, all should be well, and virtually no domestic video recorders are now fitted with manual level controls.

This is generally acceptable, but the manufacturers also decided that if manual control was not required, then visual displays could also be dispensed with. Thus there is no indication that the sound is even reaching the recorder, let alone at the correct level.

Of course, most people will be monitoring the sound via their TV or hifi system. But for any serious work, accurate monitoring can only be done with a properly calibrated VU (Volume Units) meter, which provides a set of l.e.d.s (or an analogue meter) pulsing with the level of sound.

When digitising sound (analogue to digital conversion – ADC), accurate monitoring is essential, since severe distortion results if the sound level exceeds the maximum permitted. Yet the sound monitoring provided by many software packages is disgraceful. With some software, although sound levels are grudgingly provided to help with setting up, you cannot monitor signal levels whilst capturing audio to the hard-drive of your computer.

Likewise, the stand-alone DVD recorders now appearing generally fail to provide visual monitoring. Even if they do, it may be on-screen, in a display so large that simultaneous picture monitoring is made impossible!

MONITORING OPTIONS

This month we look at various ways of monitoring sound. The design brief was to:

- provide accurate monitoring in dB (decibels)
- indicate that sound is actually being recorded
- show both stereo channels individually
- offer very high input impedance (to avoid reducing the signal)
- offer "loop through" so that it may be connected in series with output/input devices

Applications include:

- monitoring when duplicating video productions
- monitoring the signal reaching a master recorder
- monitoring the signal when digitising sound to computer

BACKGROUND INFORMATION

We will start by outlining some of the terms used in connection with sound recordings:

Digital vs Analogue

"Digital is always better!"? You would think so by the way the media (and advertisers) always boast about "digital". We even have *digital fireworks* – according to the media, the firework display in Australia to mark the New Year was *digital*. Presumably they just mean *computer controlled*. We have *digital headphones* – whatever that means. Will we also enjoy *digital speakers* and *digital light bulbs* in the future?

People associate digital with accuracy – it's well known that you can copy a CD or a digital photo, and obtain a perfect copy. What seems to be less understood is that the very process of *digitising* introduces errors. When sound is digitised for recording on a CD, for instance, the amplitude (height) of the analogue waveform is measured approximately 44,000 times a second (44kHz sampling).

This may seem a fantastic achievement, but many people claim that they can still hear imperfections in a CD. The number of binary bits used to encode each sample is set at 16, and this limits the accuracy to which the analogue waveform is measured. So although you can make a perfect copy, the process of conversion from analogue to digital is imperfect.

DVD sampling rates can be much higher (e.g. 96kHz), and the number of bits per sample is also higher. So you would be a very fussy listener to detect any imperfection here!

When converting your own analogue signals to digital (e.g. when recording to computer) it is essential not to over-record, as the resulting distortion is very unpleasant. Under-recording will result in a less accurate representation of the sound, as well as a noticeable increase in noise generated by the electronics. Hence accurate level monitoring is essential.

Dynamic Range

The dynamic range of an audio signal relates to the difference in level between the loudest and quietest discernible signals. Natural sounds offer a very wide dynamic range. The experience of listening to a live orchestra or band is quite unlike listening via a recording, due largely to the very wide dynamic range of the former.

Our ears are capable of hearing a pin drop, then seconds later, coping with a loud explosion. If you tried to record the sound of a pin dropping you would need to advance the recording level significantly, then reduce it substantially for the explosion. In other words, you would have reduced the dynamic range of your recording.

Reducing the dynamic range decreases the realism of the sound, but it is almost always essential if quiet sounds are not to be lost in the background noise produced by even the finest audio systems. If you listen to recordings in a car, the dynamic range will need to be even smaller, if the quiet sounds are not to be swamped by the noise of the car, and you are not to be deafened by the loudest sounds.

An audio compressor (not to be confused with digital compression which is totally different) reduces the dynamic range, and is especially useful when making live

recordings. Some recorders provide a built-in dynamic range compressor.

The dynamic range was quite limited in the days of gramophone records. If the dynamic range was too large, the groves would merge together, and if too small, the sound would be lost amongst the background noise. Moreover, the bass (which needs more space) had to be compressed more than the treble.

If a record is played back through an ordinary amplifier (e.g. via a microphone input) the resulting sound seems to lack bass. An RIAA (Recording Industry Association of America) amplifier is needed. This has a special tone correction circuit, which restores the bass to the correct level. Hence amplifiers often have a separate *phono* or *gram* input specifically for record decks.

If gramophone records were bad, domestic tape recorders were far worse! The background hiss was considerable and so even the quietest sounds had to be recorded at a high level. It was thanks to Dolby and his famous noise reduction system that tape became a serious recording medium.

Headroom

Sound levels are constantly changing, and no matter how carefully the recording level is set, there will always be an odd signal peak which exceeds the expected level. Hence it is important to leave "headroom", i.e. record at a level that still allows for sounds of much higher levels without causing distortion.

Noise

All electronic systems create noise. Noise refers to any unwanted signal, but is often apparent as "hiss" in audio signals. Hiss is generated by all the components in an audio system and so even digital audio systems can suffer.

"Hum" is another common form of noise, often caused by interference from mains equipment. The *signal-to-noise ratio* is a figure often quoted in equipment specifications; the higher the ratio, the lower the noise.

R.M.S. VALUES

We often need to measure the voltage of an audio signal, and since an audio waveform is moving between zero, positive and negative, this poses a problem. The graph shown in Fig.6.1 represents a sinewave – the sort of sound produced by a tuning fork.

If you tried to measure the voltage of the signal using a normal d.c. voltmeter, the reading will be zero. This is because the voltmeter will be attempting to take an average of the signal, and so the negative parts of the wave will cancel the positive parts.

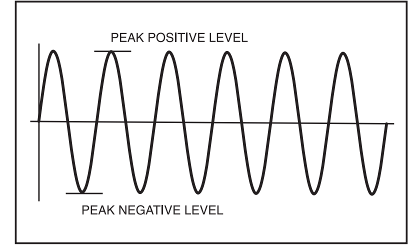


Fig.6.1. A sinewave and its peak voltage levels.

What we really want to know is the *peak voltage* – the maximum value present in a varying or alternating voltage, i.e. normally the value between 0V and the positive peak voltage. (Do not confuse this with the *peak level* on a VU display – more later.)

An allied term is *peak-to-peak* value, which is the absolute difference between the voltage peaks above and below zero. In the case of an evenly swinging a.c. waveform, the peak-to-peak value is twice that of the peak value.

Since taking an *average* reading will produce an answer of zero, a more useful technique has been devised, known as the *r.m.s.* (root of the mean square) value. The r.m.s. value of an a.c. signal is the value which has the same energy as the equivalent d.c. value. Mathematically, the r.m.s. value is given by:

r.m.s. value = peak value / √2
i.e. r.m.s. = peak / 1·414

So if the peak value in Fig.6.1 is 1V, the r.m.s. value is 0·7V.

Our mains electricity supply (in Europe) is rated at 230V r.m.s. Hence the peak voltage is:

Peak = 230 × 1·414 = 325V

If you use an ordinary multimeter and set it to a.c., you will obtain a reading somewhere near the r.m.s. value. Taking a true r.m.s. value for various waveforms is complicated, and so voltmeters which achieve this are more expensive.

A VU display would flicker very badly if it tried to show each part of each waveform, and so a VU display should indicate the r.m.s. value at any one time. Consequently, when we refer to the *peak sound level* we mean the highest r.m.s. level.

MEASURING IN DECIBELS

It's time to tackle decibels (dB) – a system which to some might appear to be designed to confuse! In fact the decibel scale (invented originally for use in telephone systems) is cunningly designed to cope with the complicated way in which humans hear sound.

The problem is that human hearing is very sensitive, and in a quiet atmosphere we can hear a pin drop. We have a sort-of automatic gain system, which enables us to identify very quiet sounds, and also eliminate unwanted noise. When a loud sound occurs, our hearing sensitivity is reduced accordingly.

Hence, when you advance the volume control of your hifi system or TV, the signal driving the speakers has to be increased by a much greater degree than the turning of the control knob would suggest. This is why, when you buy a potentiometer for use as a volume control, you choose a logarithmic (log) type. These are designed to increase the signal by ever increasing ratios as you rotate the control. A linear potentiometer would increase the signal by equal amounts as you advanced the control – and you would have to turn it a long way before the sound appeared to increase.

This also explains why a feeble-looking 1W amplifier actually seems quite loud (it can fill a small room with sound), yet a 2W amplifier appears to offer the same amount of sound. You have to increase the power by tenfold to really notice the difference.

Measuring sound levels is quite difficult. For a start, what do you call zero? Is it the sound you would hear in a vacuum (don't try this at home, or you will explode!), or a whispering breeze? The issue is neatly side-stepped by making the scale a relative one. In other words you call any point you like the zero level, and measure relative to that.

Many hifi amplifiers feature volume controls calibrated in dB with zero marked at the top of the scale. As the sound level is reduced, the markings are shown as negative values, e.g. –3dB, –6dB etc. Some amplifiers display a sound level with zero fixed as "pretty loud", but with positive dB readings above that, and negative ones below.

A decibel scale reflects the way we hear sound. So if you advance your volume control from, say, –9dB to –6dB and then to –3dB, the sound will increase in what *seems* like a linear fashion (i.e. in equal steps). In fact the sound is actually *doubling* in power from –9dB to –6db, and doubling again from –6dB to –3dB.

To sum up, a decibel scale locates zero at any convenient point, and then measures the sound level in accordance with the non-linear way in which humans hear sound. What the circuit designer needs to know is how the recording level measured in dB relates to the actual voltage of the audio signal.

AUDIO SIGNAL LEVELS

When linking audio equipment – connecting a video player to a hifi amplifier, for example – you hope that the signal expected by the amplifier will be equal to that provided by the video player. On the whole, thanks to agreement between all the major manufacturers, it is! You hope also, that the output impedance of the video player will be compatible with the amplifier. On the whole, it is!

Some advertisers will have you believe that if equipment is to be fully "matched" it must all be bought from one company – generally the one paying for the advert. But you would be very unlucky if you had a problem when connecting different brands together.

When you connect a video player to an amplifier, the signal being sent out from the player will be at *line-level*. This is a roughly agreed standard where the signal peaks at around 1V r.m.s. It is very much a rule of thumb, but since most equipment is quite tolerant of larger or smaller signals, a line-level connection generally works very well. So how does this relate to dB?

The domestic video recorders tested for this article assume a level of 0dB at a signal voltage of about 0·7V r.m.s. If the signal is increased to 1V r.m.s., the recording level indicator reaches the top of its scale, but the analogue recording system does not distort.

Professional systems generally handle slightly larger signals, up to around 1·2V r.m.s., although in both cases signals may peak at slightly higher levels, say 2V r.m.s.

PEAK LEVEL INDICATOR

We shall now illustrate several ways in which a signal level indicator can be

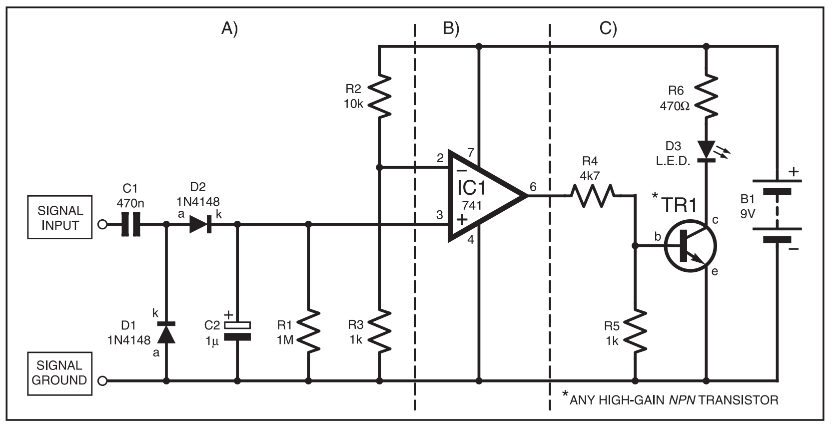


Fig.6.2. Using a comparator to detect signal level peaks and turn on an l.e.d.

designed, progressing to one that uses a bargraph display. They are intended for use with line level signals, as output by virtually all audio equipment, apart from record decks and microphones. The 0dB point is fixed at 0·7V r.m.s. and the signal will probably average at around 0·5V r.m.s., peaking at around 1V r.m.s.

We looked at op.amps in Part 3, and in particular the comparator circuit. Consider the circuit shown in Fig.6.2, in which IC1 is configured as a comparator. The a.c. audio signal is input via capacitor C1, which isolates any d.c. present. It should be non-electrolytic, and have a value of at least 100nF, preferable more, so allowing a better response to low frequency signals.

DIODE PUMP

The a.c. signal passes through C1 into the rectifying circuit comprising diodes D1 and D2, plus capacitor C2. This configuration is generally known as a *diode pump*. The diodes convert the alternating signal to a voltage that swings above zero at a level relative to the level of sound.

Rising voltages charge up C2 almost instantaneously. When the input signal level falls, C2 is prevented from discharging at the same rate by diode D2. It is through resistor R1 that C2 is allowed to discharge, but at a relatively slower rate.

We do not achieve a true r.m.s. conversion this way, but this can be largely corrected as shown later.

The value for resistor R1 of 1MΩ, in relation to the value of capacitor C2 at 1μF, provides a reasonable starting point for the circuit's signal level decay rate, but it is suggested that you experiment with other values.

Resistors R2 and R3 set the switch-over point of the comparator (see Part 3). If the audio input signal rises beyond a certain level, as set by R2 and R3, the output of the comparator (pin 6) switches high. This in turn switches on transistor TR1, so lighting l.e.d. D3. Any high-gain *npn* transistor can be used, such as a BC549.

Resistors R4 and R5 reduce the output voltage from the comparator since some op.amps (e.g. the 741) are unable to provide a 0V output when used with a single rail power supply (see Part 3).

Note that diode D2 attenuates (reduces) the positive-going input signal level by approximately 0·7V. Consequently, you will need quite a large audio signal to make the l.e.d. turn on.

IMPROVED PEAK LEVEL DETECTOR

We can turn the circuit of Fig.6.2 into something more useful by adding an amplifier stage at the input. A simple transistor amplifier, such as those discussed in Part 2, would not provide the accuracy required, but an amplifier based on one of the op.amp circuits in Part 3 will do so.

The amplifier should have a high input-impedance, so that it does not drain too much signal current from the system you are trying to measure. So a non-inverting op.amp circuit is required. Since the circuit in Fig.6.2 uses a single-rail power supply, the non-inverting amplifier has been similarly designed, as shown in Fig.6.3.

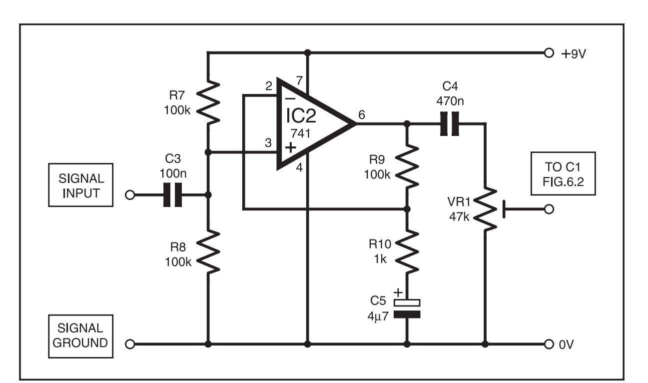


Fig.6.3. An op.amp used in non-inverting mode as a signal input amplifier.

The input signal is a.c. coupled by capacitor C3, with resistors R7 and R8 setting the midway bias level to the non-inverting input of IC2 (pin 3). The ratio of resistors R9 and R10 set the maximum gain, and some experimentation may be necessary, depending upon the type of signal applied to the input.

The output from IC2 pin 6 is a.c. coupled, via capacitor C4, to preset potentiometer VR1. This control enables the response of the peak level indicator in Fig.6.2 to be calibrated. To do this, connect a steady audio signal to the circuit, connect an a.c. voltmeter (r.m.s. if possible) to the test signal, and now adjust the level of the signal so that a reading of, say, 0·7V r.m.s. is obtained. Now adjust VR1 until l.e.d. D3 just lights.

Although the test circuits are based on 741 op.amps, almost any op.amp would be suitable, and many i.c.s are available which house two op.amps in one package, such as the excellent low-noise NE5532.

OP.AMP BARGRAPH

A simple peak level bargraph display can be created by cascading a set of op.amps as shown in Fig.6.4. The circuit is based on three op.amps but in practice any number can be employed according to the number of l.e.d.s required. The l.e.d. circuits are repeats of Fig.6.2, section C.

The resistor chain, comprising R1 to R4, sets the voltage at the inverting input of each op.amp in such a way that each output will be triggered (go high) as the signal voltage rises at the non-inverting inputs. Accurate measurements can be made if a stable and reliable power supply is employed, and the resistor values chosen to provide set voltages at their junctions.

If the resistor values are all equal, then the voltage will be divided equally at each junction. So if all the resistors have a value of 10kΩ (including R1), then the voltage at the junction of R3 and R4 will be 9/4 =

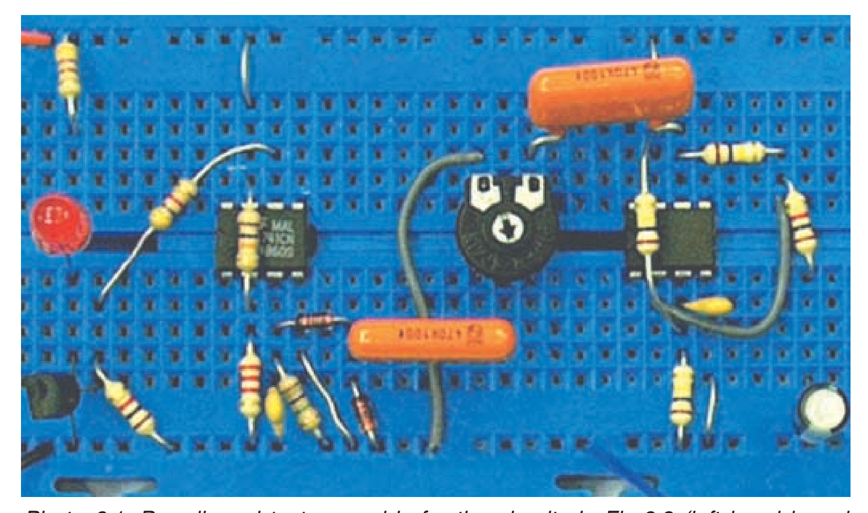


Photo 6.1. Breadboard test assembly for the circuits in Fig.6.2 (left hand board area) and Fig.6.3 (right hand area).

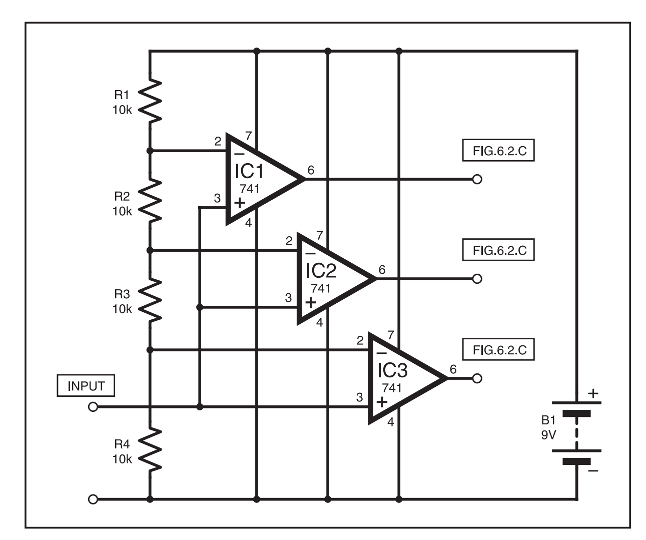


Fig.6.4. Using three op.amps in comparator mode to create a three-stage bargraph.

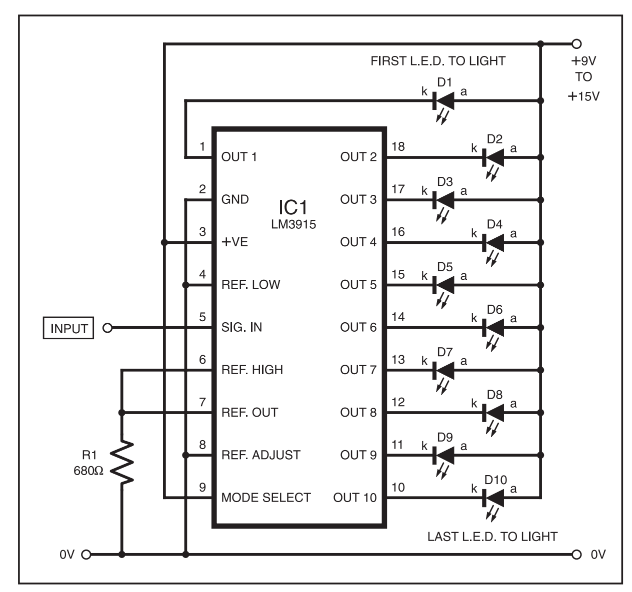


Fig.6.5. The LM3915 device is designed for use as a bargraph driver.

2·25V (assuming a 9V supply). The voltage at the junction of R2 and R3 will be 4·5V, and 6·75V at the junction of R1 and R2.

As a varying d.c. input voltage crosses these thresholds, the appropriate l.e.d. will be turned on. To monitor audio signals, the circuits shown in Fig.6.3 and Fig.6.2, section A should be added.

This op.amp bargraph system demonstrates the principle involved in VU monitoring. For serious use, however, there are a number of i.c.s available which provide much greater accuracy, and more simply. We will now look at three such devices.

BARGRAPH DRIVERS

The LM3915 bargraph driver has 10 outputs, each capable of sinking enough current to light an l.e.d. brightly. Up to four l.e.d.s can be driven from each output if they are connected in series and the supply voltage is 9V. As with the simple circuit in Fig.6.4, the device has a chain of resistors and comparators which are triggered by different input voltage levels. Its datasheet can be download from **www.national.com/pf/lm/lm3915.html**.

A basic test circuit is shown in Fig.6.5. Note that the l.e.d.s do not require series resistors since the i.c. regulates the output current, according to the value of resistor R1. The pin functions are as follows:

Pin 2. 0V supply
Pin 3. Positive supply (3V to 25V, but note that 9V to 15V is better for this demonstration)
Pin 4. Low end of resistor divider chain
Pin 5. Signal input
Pin 6. High end of resistor divider chain
Pin 7. Voltage reference output (1·25V if pin 8 is connected to 0V)
Pin 8. Reference adjust
Pin 9 Mode select

Pins 1 and 10 to 18 are the l.e.d. connection pins, where pin 1 is the first to react to a voltage rising from 0V, followed by pin 18, then 17, etc., with pin 10 the last to react.

Note that the pins *sink* current, in other words an l.e.d. has its cathode (k) connected to the pin. The current flowing through the l.e.d.s, and hence their brightness, is set by resistor R1. The value of 680Ω can be increased for a dimmer display, with reduced power consumption.

The arrangement shown in Fig.6.5 provides a bargraph display where the l.e.d.s light in a continuous bar effect – like the display often seen on quality tape recorders. If Mode Select pin 9 is left *open-circuit*, i.e. not connected to anything, the display becomes *dot mode* in which only one l.e.d. lights at any one time. This reduces the current consumption but is probably not as attractive.

The audio signal is input at pin 5. The i.c. will accept an a.c. signal (audio signal) as the device is internally protected against negative voltages, and shows the positive peak value of the signal. In the configuration shown in Fig.6.5, an input signal of 1·25V gives a full scale display (f.s.d.).

The circuit appears remarkably simple, but there are several points worth noting, not least of which is that with an f.s.d. of 1·25V, the response of the display is quite poor. It is preferable, therefore, to amplify the input signal by, say, 10 times.

The extra gain can be provided by the LM3915 itself. To do this, and assuming a 10V power supply, pin 6 should be disconnected from resistor R1 and from pin 7, and instead tied to the positive supply rail. If the power supply is 10V, the relationship between the voltage, dB value and the l.e.d. lit is as follows:

L.E.D.	***dB***	***Voltage***
D1	–27	0·45V
D2	–24	0·63V
D3	–21	0·89V
D4	–18	1·26V
D5	–15	1·78V
D6	–12	2·51V
D7	–9	3·55V
D8	–6	5·01V
D9	–3	7·08V
D10	0	10V

Remember that we have assumed that the input signal has been amplified by ten times. (If the supply voltage is 9V, of course, the values will change accordingly.)

Note that the dB range is in steps of 3dB, and the voltage (not power) doubles every 6dB. The 0dB point being at the top of the scale is not particularly convenient, and in this and other respects, the scale is not in accordance with the type found on many top quality recorders.

However, another almost identical bargraph driver is available, the LM3916, which operates in exactly the same way, but provides the following scale (with a 10V power supply):

L.E.D.	***dB***	***Voltage***
D1	–20	0·71V
D2	–10	2·24V
D3	–7	3·16V
D4	–5	3·98V
D5	–3	5·01V
D6	–1	6·31V
D7	0	7·08V
D8	1	7·94V
D9	2	8·91V
D10	3	10V

The LM3916 may be substituted for the LM3915 and provides a more helpful display by showing very quiet sounds on the first three l.e.d.s, but with higher resolution around the critical 0dB point. Its pinouts are the same as the LM3915.

Be aware that the i.c.s in this bargraph driver family are prone to oscillations, and some care must be taken, particularly when driving the l.e.d.s in bar mode, where the total current flowing is considerable. This current can result in voltage fluctuations which cause instability. When using a supply of more than 7V, it may be preferable to use a resistor in series with the l.e.d. chain, a value of around 15Ω is suggested.

BARGRAPH DRIVER LB1443N

The LB1443N bargraph driver made by Sanyo is available as a 9-pin s.i.l. (single-in-line) device. It offers five outputs, operating in dot-mode.

As with the previous bargraph drivers, the system comprises a number of comparators. In this case, their inverting inputs are all tied to the output of an internal amplifier. The non-inverting input of each comparator is connected to a resistor chain, one end of which is connected to a regulated voltage. The other end of the chain is connected to 0V, and so an accurate and

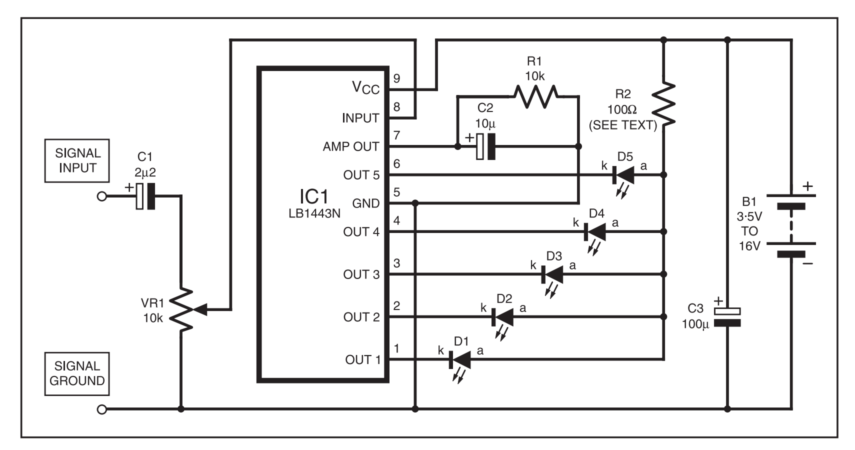


Fig.6.6. Test circuit using the LB1443 bargraph driver.

stepped voltage is applied to each non-inverting input.

Hence each comparator responds to a separate voltage at its inverting input. Each comparator output is connected via a constant current driver circuit to the pins intended for connection to the l.e.d.s.

An example application circuit is shown in Fig.6.6, in which a potentiometer, VR1, is used to adjust the voltage at which particular l.e.d.s are turned on in response to an a.c. input signal. If an audio signal of 1V r.m.s. is applied to the input, and the potentiometer is adjusted so that l.e.d. D3 is just lit, then the following table shows the relationship between the outputs and the signal applied at the input:

L.E.D.	*Signal Voltage*
D1	1·67V r.m.s.
D2	1·33V r.m.s.
D3	1·00V r.m.s.
D4	0·67V r.m.s.
D5	0·33V r.m.s.

The circuit's response time is set by capacitor C2 and resistor R1. To slow the response time, increase the value of C2. The device will operate on a wide supply range from 3·5V to 16V. Note that ballast resistor R2 may be replaced by a link wire if the supply does not exceed 9V. For voltage supplies up to 16V, R2 must be included, at a value of 100Ω.

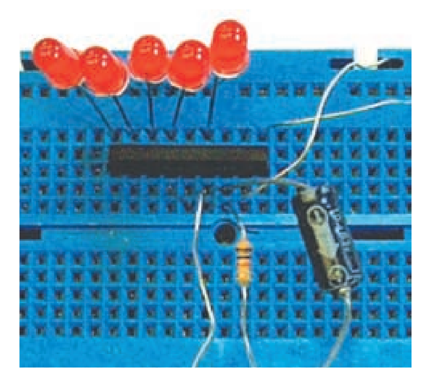


Photo 6.2. Test assembly for the circuit in Fig.6.6.

LB1412 BARGRAPH DRIVER

The previous circuit is fairly easy to make and test, but for serious recordings a larger number of l.e.d.s is required. This can be achieved by using the LB1412 bargraph driver.

An example of a circuit using the LB1412 is shown in Fig.6.7. It has 12 outputs which operate in bar mode, driving l.e.d.s. D1 to D12. The connections shown are in accordance with the manufacturer's datasheet, which may be downloaded from **http://service.semic.sanyo.co.jp/semi/ds_pdf_e/lb1412.pdf** or via **www.datasheetcatalog.com**.

Ballast resistors R3 to R7 set the brightness of l.e.d.s D8 to D12, but l.e.d.s D1 to D7 have their brightness set by the value of resistor R8. It is suggested that the l.e.d.s should be green for D1 to D4, yellow for D5 to D7, and red for D8 to D12.

The LB1412 has a latch on each of its D8 to D12 outputs. When the Reset pin (11) is open, peak hold of l.e.d.s D8 to D12 occurs, indicating the highest signal level received. The latch is automatically reset after a brief period controlled by the values of capacitor C4 and resistor R9, about two seconds with the values suggested. When the Reset pin is connected to the 0V line by switch S1, the latches are held in a reset state and no peak hold occurs.

The audio signal is input via level control potentiometer VR1, from which it is a.c. coupled via capacitor C1 and resistor R1 to the input (IN1) of an internal inverting amplifier. The values of R1 and feedback resistor R2 set the gain of the amplifier. The amplifier's output (OUT1) is a.c. coupled via C2 to the input (IN2), which feeds to the common connection between the comparators.

Capacitor C3 sets the time for which the l.e.d.s stay on. Its value can be between 1μF and 4·7μF. The latch timing when active overrides this period for l.e.d.s D8 to D12.

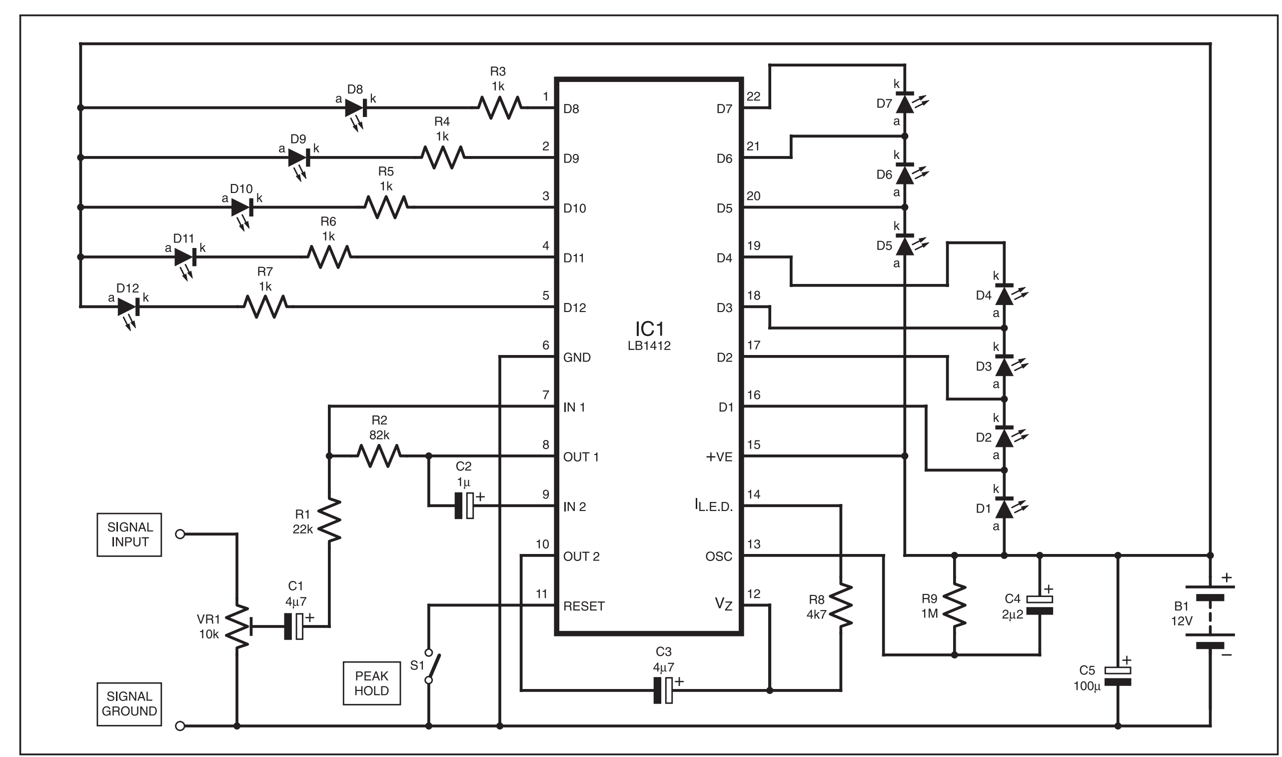


Fig.6.7. Test circuit for the LB1412 12-stage bargraph driver.

The signal amplitude scale is shown in the table below. Note that the input voltage is not shown as it depends upon the gain of the amplifier as set by resistors R1 and R2. Later we will show how the 0dB point can be accurately set.

L.E.D.	*dB*
D1	–20
D2	–15
D3	–10
D4	–7
D5	–5
D6	–3
D7	–1
D8	0
D9	+1
D10	+3
D11	+5
D12	+8

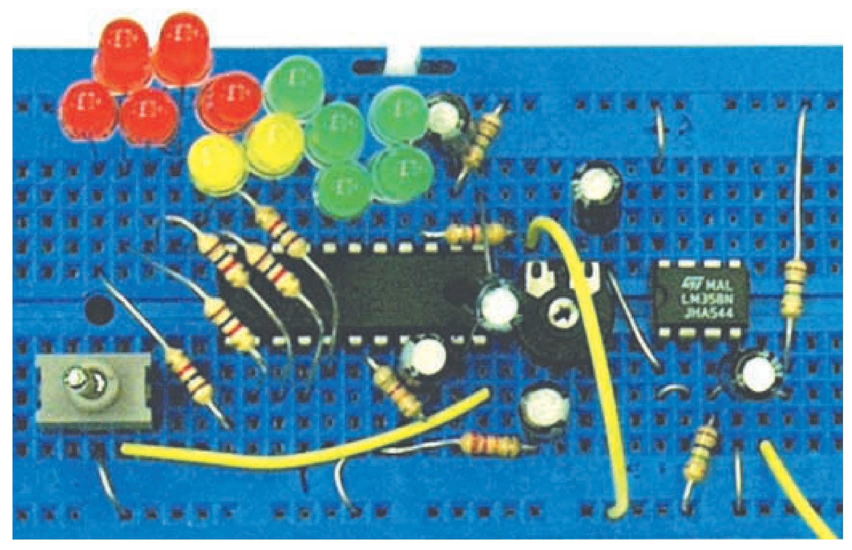


Photo 6.3. Breadboard test assembly for the circuit in Fig.6.7.

BUFFERING

As shown in Fig.6.7, the input signal is fed to a 10kΩ resistance (VR1), and so the input impedance of this circuit is also 10kΩ. This is quite low, and may affect the amplitude (strength) of the input signal a little, depending on the signal source impedance.

In Part 3 we showed how a *voltage follower* can be made using a single op.amp. The purpose of the voltage follower is to provide a much higher input impedance for the signal. As its name suggests, the output voltage copies the input voltage.

The voltage follower in Part 3 is a dual-rail circuit. The circuit shown in Fig.6.8 has been modified so that it can operate on a single-rail power supply. To achieve this it is necessary to add resistors R1 and R2, and electrolytic capacitors C1 and C2, as explained in Part 3. Note the polarity of the capacitors, each positive side is towards the op.amp.

The input impedance is equal to the value of resistors R1 and R2 in parallel, i.e. 500kΩ, although the input impedance of the op.amp must also be taken into account.

The op.amp could be a type 741, though the rather high values of R1 and R2 would make an op.amp with a higher input impedance desirable, such as the LM358N, a 8-pin chip which houses two op.amps, and is therefore ideal if a stereo version of the system is to be built.

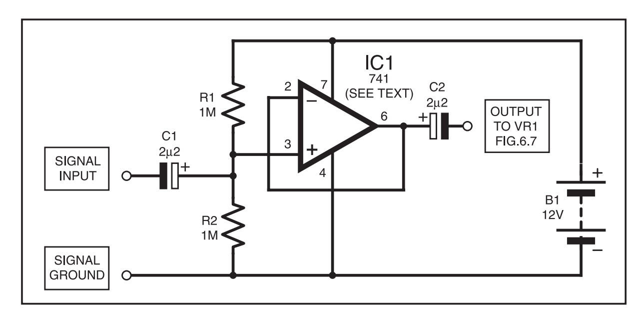


Fig.6.8. Circuit for a single-rail op.amp voltage follower.

CALIBRATING

Ideally, a sinewave signal of about 1kHz from a signal generator should be used when calibrating the bargraph circuit of Fig.6.7. If a true r.m.s. meter is not available to set the signal amplitude, use an a.c. meter. In tests it was found that a true r.m.s. reading of 0·7V gave a reading on an ordinary a.c. meter of 0·6V.

For readers who have a computer and know how to use a **.WAV** file through its audio system, a 1kHz signal file is available for free download from the *EPE* web-site at **www.epemag.wimborne.co.uk**, in folder **PICs/Teachin 2004**.

If neither signal source is available, you can still experiment by inputting any audio signal to the circuit.

If you are using a controllable 1kHz source, adjust its amplitude to obtain a reading of 0·7V r.m.s. on the meter. Adjust level control VR1 of Fig.6.7 until the display just turns on l.e.d. D6. You should now find that increasing the volume control for a reading of 2V r.m.s. will cause the display to reach l.e.d. D12.

Some professional recording systems allow signals to peak at 2V, but for domestic use, the display should not go above l.e.d. D7, other than for the occasional peak.

NEXT MONTH

In Part 7 next month we discuss circuits for moisture detection, and also radio links.

INTERFACE



Robert Penfold

SOME PRACTICAL SUGGESTIONS FOR CASE MODDING YOUR PC

OF LATE, the *Interface* articles have dealt with fairly heavyweight matters, but this time one of the lighter sides of computing will be considered. Anyone who has attended a few computer fairs over the last year or so could hardly fail to notice the latest computer craze, which has become known as "case modding".

This term actually covers a range of computer modifications. These include over-clocking and the no-compromise cooling systems that go with it, and making your PC as quiet as possible for audio/visual applications or because you are simply fed up with the noise.

PC Changing Rooms

Most case modding though, is aimed at making a PC look prettier and fit in well with the decor of a modern home. At its most simple level case modding is just painting the computer's side panels a more suitable colour than IBM grey, and perhaps adding a few badges.

The more common approach these days is for a transparent panel to be fitted in the left-hand side panel so that the interior of the case can be seen. Cases that already have this panel and a suitably trendy colour scheme are now readily available and are apparently big sellers. These are known as pre-modded cases incidentally.

The real point of the transparent side panel is to enable coloured lighting units to be installed inside the PC. Various types of lighting are produced, and one of the most popular is a fluorescent tube powered from a drive power lead via a simple inverter.

These tubes often produce two colours such as red at one end and blue at the other. A case modding kit that has a two-colour tube, inverter, on/off switch, and an adaptor to enable power to be tapped from a drive power lead is shown in the photograph below.

A slightly more adventurous form of internal lighting has an ultraviolet tube that produces little or no visible light. This is used in conjunction with specially coated data cables for the disk drives. The cables fluoresce under the ultraviolet "light" to produce an eerie glow.

Other types of lighting are used, such as l.e.d.s mounted in processor cooling fans made from translucent plastic. Electroluminescent (EL) strips and panels are also popular. Like fluorescent tubes, these require relatively high operating voltages but small currents, so they are powered via a small inverter. The panels are available in various designs and they are usually fitted on the rear surface of the transparent window using double-sided adhesive tape. Various flashing and moving lights are also available.

Light Switch

Some lighting units are supplied complete with an on/off switch. Most of the lighting units have long operating lives, with something like 15000 hours being typical for the ordinary fluorescent tubes for example. The ultraviolet units have much shorter operating lives though, and seem to be comparable to filament bulbs in this respect. The on/off switch can be used to conserve ultraviolet tubes, or to turn off other types of lighting if you have simply had enough of them for a while.

The problem with an ordinary switch is that it requires a hole to be made somewhere on the PC case. Mounting the switch near one corner of the left-hand side panel is usually the only practical option.

However, few PC owners are prepared to start drilling holes in the case, which will almost certainly nullify warranties and maintenance contracts. One possibility is to replace the existing switch with a miniature type, with the new switch being mounted on a blanking plate fitted behind any vacant expansion slot. This results in the switch being positioned at the rear of the PC where access is likely to be difficult, but it avoids the need for any drilling of the main casing.

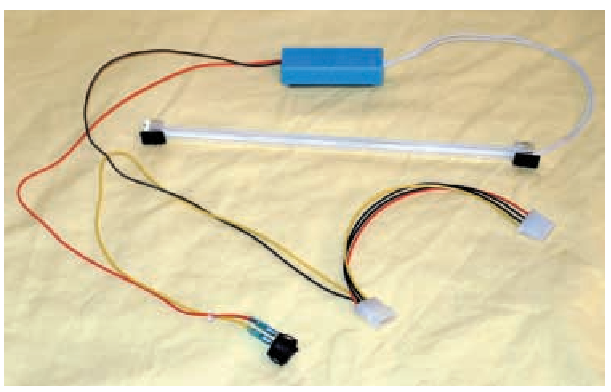
Incidentally, the fluorescent tubes, inverters, or whatever are normally mounted in the PC case via adhesive pads, and do not require any drilling. This is important, because getting any "metal swarf" into the electronics of a computer is a good way of causing short-circuits and possibly a lot of expensive damage. Many of the inverters have the option of screw fixing, but it is probably best to ignore this and settle for the safer method of using adhesive pads.

Software Control

A basic infra-red controller offers a viable means of switching an internal lighting unit on and off, as would a simple radio link. In both cases the receiver could have problems with digital noise from the computer, and either method of control would perhaps be a bit "over the top".

A more simple approach is to use software control via a simple interface on an output line of a serial or parallel port. A wire from the output has to be taken from the outside of the PC, through the case, and into the interior, but the rear of most PCs is riddled with suitable holes. A socket mounted on the blanking plate of an expansion slot offers a neater method.

The previous *Interface* article covered the use of serial port handshake lines for simple input/output purposes, and using the parallel port data and handshake outputs for simple control applications has also been covered before. Any digital output lines are obviously well suited to a simple on/off switching application of the type involved here. The circuit diagram shown in of Fig.1 uses a simple common emitter switching transistor (TR1) driven



A typical lighting kit comprising a two-colour tube, inverter unit, on/off switch and power adaptor.

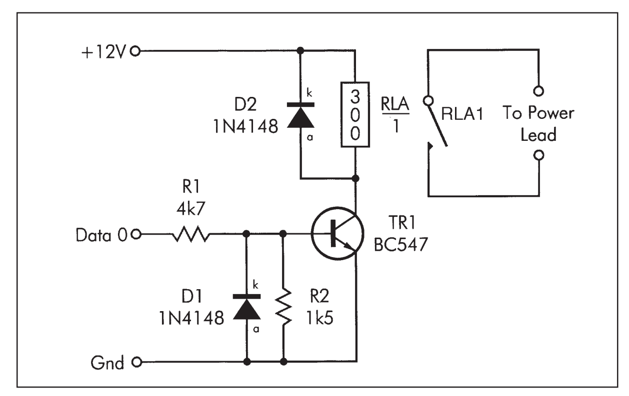
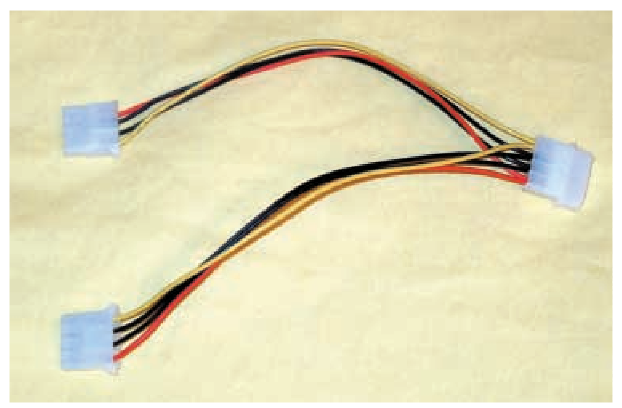


Fig.1. A simple relay driver circuit, driven from the Data 0 output of the printer port.



A supply splitter is the easiest way of obtaining the required +12V supply for the relay circuit.

Data 0

13 7 1

25 14

Ground

Fig.2. Details of the connections to the parallel printer port.

from the Data 0 output of the parallel port. Transistor TR1 is switched off with the input in the low (0 volts) state.

Setting the Data 0 output high (+5 volts) switches on transistor TR1, which in turn activates the relay (RLA). A set of normally open relay contacts (RLA1) are used in place of the on/off switch supplied with the lighting kit. Of course, if the lighting kit was not supplied with an on/off switch, the relay contacts can still be wired into the positive supply to the inverter.

The lighting is switched on when Data 0 is high, and switched off when it low. A protection diode, D2, suppresses the high reverse voltage generated across the relay's coil when it is switched off. The relay can be any 12V type that has at least one pair of normally open contacts and a coil resistance of about 200 ohms or more.

Power Needs

Probably the easiest way of obtaining the +12 volt supply is to use a supply splitter, similar to that shown in the above photograph. The socket connects to a drive power lead of the power supply. If this lead was previously used with a disk drive, one plug of the adaptor is used to restore power to that drive. The other plug can be cut off to leave four leads that give access to the +5V and +12V supplies of the PC.

The two black leads both connect to the chassis of the PC. The red and yellow leads are respectively the +5V and +12V volt supplies.

The circuit can be driven from the DTR or RTS handshake output of a serial port. Details of the connections to the printer port are provided in Fig.2. These connections are made via a 25-pin male D-connector.

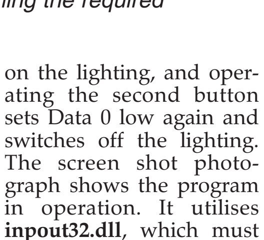
Software

A very simple program is all that is needed in order to control the relay circuit. Add two command buttons to the form and change their captions to something like "Lights On" and "Lights Off". Then add this simple program:

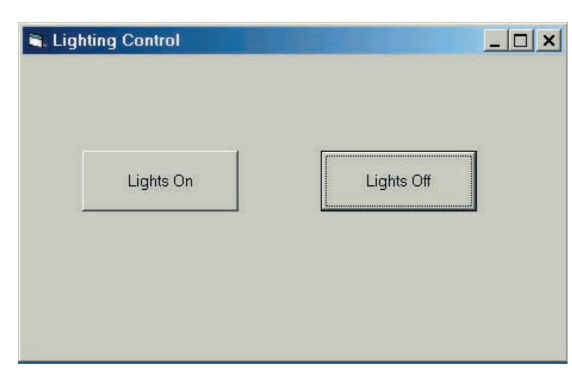
```
Private Sub Command1_Click()
Out &H378, 1
End Sub

Private Sub Command2_Click()
Out &H378, 0
End Sub
```

Operating the first button (Command1) sets the Data 0 output high and switches on the lighting, and operating the second button sets Data 0 low again and switches off the lighting. The screen shot photograph shows the program in operation. It utilises **inpout32.dll**, which must be available to the system.



If you wish to experiment with the program yourself, remember that the BAS file supplied with **inpout32.dll** must be loaded into Visual BASIC. Without this file Visual BASIC will not know that it needs to use **inpout32.dll** and error messages will be generated. Only the *new* version of **inpout32.dll** is suitable for PCs running Windows NT4, 2000, or XP.



Screen shot of the simple control program in operation.

Why Not DIY

An advantage of being into electronic project construction is that with case modding you are not limited to using commercially produced lighting. There is endless scope for "doing your own thing". The brightest of modern l.e.d.s produce quite respectable light levels, and are certainly a far cry from the original units. This makes them well suited to DIY PC lighting units.

The circuit diagram shown in Fig.3 enables eight l.e.d.s (D2 to D9) to be controlled from a data output of the printer port. Resistors R3 to R10 set the current to each l.e.d. at about 10mA, which is sufficient to give good brightness from an ultrabright l.e.d. Of course, l.e.d.s of different colours can be used if desired.

The l.e.d.s can just be left running continuously in normal use, or a simple program can be used to make them flash. Another possibility is to have a larger display of 16 or 24 l.e.d.s, with each set of eight controlled from a different output of the printer port. This would enable a simple "moving" lights display to be produced. Using all eight data outputs of the printer port with each one driving (say) three l.e.d.s some quite complex animated lighting effects could be produced.

It would probably be possible to vary the brightness of the l.e.d.s using pulse width modulation, but the software might consume too much processing power. For more complex displays it would probably be better to use a PIC microcontroller or discrete logic to provide the required effect, with software and a simple interface being used to provide on/off control.

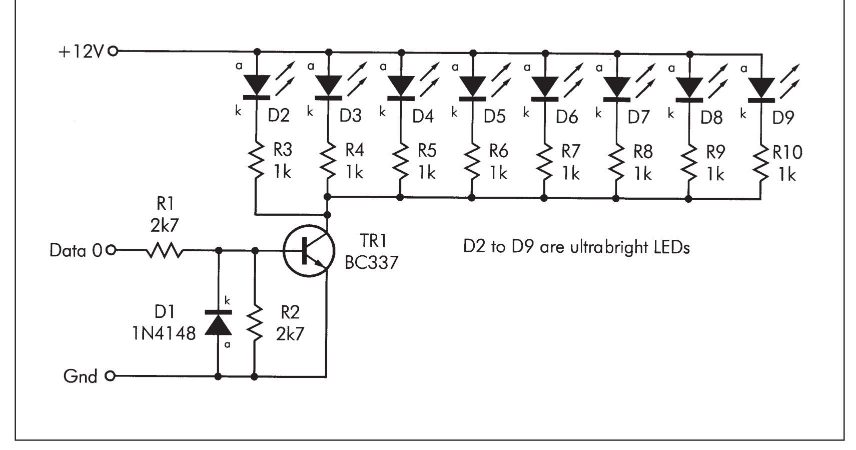


Fig.3. This simple switching circuit can drive up to about eight l.e.d.s.

READOUT

Email: john.becker@wimborne.co.uk

John Becker addresses some of the general points readers have raised. Have you anything interesting to say? Drop us a line!

All letters quoted here have previously been replied to directly.

WIN AN ATLAS LCR ANALYSER WORTH £79

An Atlas LCR Passive Component Analyser, kindly donated by Peak Electronic Design Ltd., will be awarded to the author of the *Letter Of The Month* each month.

The Atlas LCR automatically measures inductance from 1μH to 10H, capacitance from 1pF to 10,000μF and resistance from 1Ω to 2MΩ with a basic accuracy of 1%.



★ LETTER OF THE MONTH ★

PARALLEL PERSEVERENCE

Dear EPE,

I have just got *TK3* working beautifully. I must say now how impressed I am with the service you provide. I thought it might be useful to let you know some difficulties I have experienced. Nothing in this world is perfect, but it is fun. Worth the effort to get it right.

I had a great deal of trouble obtaining TK3's disassembly facility. I use a couple of keyboard computers. One is an old 386 laptop which I use in MSDOS with PCBoss as a shell and Pedit as word processor. I tried that first of all and did not expect the disassembly to work, which it didn't. Then I tried another PC, which is an AMD 1600 in a Jetway board, running Win98. I was puzzled to find that I had no disassembly from this either.

Some time later I realised that it had to be the design of the PC motherboard. I bought a PC PCI-1284 EPP/ECP parallel card together with a top quality cable from Simple Ltd. The card came in a box with good installation instructions. To get it working, though, it was moved three times, eventually I had to disable LPT1 and firmly allocate memory 0278 and IRQ5 to LPT2, leaving 0378 to the new card which oddly insists on using IRQ10. Success, *TK3* worked fully. However, it had disabled my Network card which requires a bus Master socket. It took time but they both work now. I checked a PIC16F873 in disassembly mode and its 1s were displayed beautifully.

My background: I am a wirehead who worked in the RAF and industry until the mid-sixties. I made my first wireless when I was 13-14, and subsequently was an RAF Apprentice (Brat) and worked with wireless and radar very big and very small. I got sick of it and got involved with many other things, but there is no escape from one's first love. I keep coming back. I have made many efforts to get involved with microprocessors and used a little Basic some 20 years ago. As you have said yourself the directly wired approach is often the quickest, and I tend to go that way.

I have found over the years that point to point wiring is very difficult to do without making mistakes and when integrated circuits are involved can be both difficult to trace and expensive. From now on I will make my own boards. Seeing the work you have done with PICs, and having a project in mind for which the PIC is the best solution (auto machining), I have begun.

My reason for writing was not only to express my satisfaction with your work and *EPE*, but to draw attention to what can be difficulties in installing a parallel card. The slogan is "think, persist, sleep on it, look for help, *but*, don't give up, it's worthwhile in the end."

Alan Jones, via email

Thanks for your kind words Alan. I'm glad you're getting on so well, despite teething problems. Yes, PICs are fun, and good for the brain cells. I too taught myself about PICs, some eight years ago, and am still learning new aspects. I've never installed a parallel card, but thanks for the warning. I thoroughly agree with you about never giving up in the face of problems!

DOWNLOADING FILES

Dear EPE,

I have tried numerous times from different machines to download from your FTP site but I have had no success. Every time it gives me the same error message. What must I do? I've tried the "Enable Folder View of FTP sites" in the settings page.

Derick Louw, via email

Webmaster Alan Winstanley received Derick's query and responded to him:

The FTP server is working for sure. It is now on a faster server and responds more quickly than ever. If you continue to have problems, first see if you can access other FTP sites correctly, e.g. **ftp://ftp.demon.net**. If you can't access that either, then there is something preventing FTP access, usually it is a firewall on a commercial LAN.

If you can access another FTP site, then check your spelling is absolutely correct in the URL. People often spell "wimborne" incorrectly. The correct address is **ftp://ftp.epemag.wimborne.co.uk**. Also try the Classic view link on the Downloads page. Check your local system for firewalls, e.g. Internet security software, that may prevent FTP access. Try to access the FTP site from a different PC. If it works OK on that machine, then there is a problem with your local setup.

If possible, try a different browser, e.g. Netscape 7.0 or the free version of WS_FTP software from **www.ipswitch.com**.

At present I can't see any other reason why you shouldn't be able to get through. The other answer is to use the official mirror site, linked on the Downloads page.

Alan Winstanley

MAKING TRACKS

Dear EPE,

Regarding Harry Welborne's March '04 letter about making p.c.b.s from your Online editions – when you use Print from the menu in Adobe Acrobat there is a section at the top of the printing options relating to your printer. You should be able to access them via this section. Most printer menus allow you to stipulate what percentage size to print at. A few experimental print runs should establish the scaling factor to use.

An alternative is to use the Print Scrn key to capture the page to the clipboard and paste it to a drawing or photo program and scale accordingly. You could even paste it into Word and scale it by a specified amount.

Lionel Carter, Woodley, Berks, via email

Many thanks Lionel.

BLUER STILL!

Dear EPE,

Zaphod Beeblebrox (*Readout* March '04)? I think I am more a Ford Prefect but my wife says she thinks of me as that robot thingy that stumbled along behind moaning all the time!

Don't knock the copper bracelet brigade. Just think of the industry it supports. Seriously though, since copper is one of the trace elements in our bodies, then wearing it must transfer either a few atoms to our insides, or at least react with the body's secretion of salt to provide a bit extra electrical power. Over the years I must have absorbed a lot of it, to say nothing of the lead and resin fumes. My body must be so conductive it may explain my lifetime's tendency to shake hands with the power station electrics!

Another thing I notice, as one gets older, is the trend of the call centre where a mindless moron ignores your explanation of a fault and just reads from a checklist of impossible tests. Since most firms, with a few notable exceptions, absolutely refuse to sell a circuit diagram these days in case you saved yourself a service call, it's a wonder that anything gets mended.

Regarding the Board on Radio letter (also Mar '04) – I only recently gave away my Eddystone 640 with a Q5er used as a second i.f. unit. I have still got a home-brew Heathkit HW150 and several bits of war surplus stuff. Amazingly, they still work but if anything goes bang spares are impossible to get. According to TV antique programs these sorts of thing are worth a fortune, but people wanting to buy them at all are very thin on the ground.

Wanting a list of useful inventions? How about: lamp unit to flash to tell a deaf bloke the phone is ringing; same connected to a carbon dioxide alarm; helicopter ejector seat; solar powered torch; telescope for use in underground astronomy; double glazing telesales person exterminator!

Looking into the crystal ball I think the future generations will think us too timid in our approach to the electronic age. Instead of the tiny 2-chip boxes published in the mags, we should be thinking of a much bigger box reliably and electronically controlling our houses.

G.S.Chatley, via email

Thank you GS. I guess I too relate to Ford, but in younger days would have longed to relate with Trillian! My brother is into robotics and has commercially produced robotic bar-tenders that look just like Marvin (that robot you refer to), and they talk back to customers in an equally despondent tone!

I must differ with you, though, about old radios etc. Firstly, we have a sister publication, Radio Bygones*, which is aimed at those who love to obtain, repair and bring back to life ancient radio sets and the like. It is a very active hobby.*

Secondly, my wife and I frequent antiques and collectables fairs from time to time. It is obvious from these too, that collecting radios is a thriving activity for lots of collectors. The prices can reflect that popularity!

Your other comments are food for thought – anything to add, anyone?

PRAISING SMDS

Dear EPE,

I recently found Lyn Jones special feature in Feb '04 on surface mounted devices (SMDs), very interesting. I have only made projects using through-hole components, but want to now start using SMDs. This article has now given me more confidence to experiment. It is a problem that, as very much an amateur, I do not want to spend lots of money on specialist equipment that I do not regularly use. One is always trying to achieve what one wants, but investing in the minimum of equipment.

This article gives me hope that I can use SMD components without spending too much money on specialist SMD soldering equipment. I was hoping *Shoptalk* would include details of where one could purchase the SMD components for Lyn Jones example circuit. Perhaps you could extend the feature with some more example circuits and one of the component suppliers could offer a kit with the example boards and the SMD components!

The projects I have made from your magazine, have all worked, and given me confidence to continue with electronics.

While looking around for SMD supplies I came across Bill Mooney's web site at **www.billssmd.mcmail.com/**. Hopefully he will update it soon. I will get his book sometime and his listing of firms selling SMDs is useful if a little out of date.

I also looked at Farnell and they do an SMD development box, part no 119994, designed to provide the basic information and tools to enable an engineer to evaluate the use of surface mount technology in addition to constructing some simple circuits.

Farnell's box contains: two project p.c.b.s – Logic Probe and Mains Cable Detector; tube of solder paste plus application needle; a selection of components to build the projects; pair of tweezers; magnifying glass; booklet on SMD technology and p.c.b. design recommendations; cleaning wipes; Weller 0·4mm soldering tip for fine SMD work.

However, at £61.46 it is a bit pricey, but if I have some spare cash I may give it a go. Alternatively I will wait until I am again in Germany and I can get some SMD devices from Conrad (like Maplin, but stock more items).

Richard Chandler,
via email

Thanks for the info Richard. Glad you enjoyed the SMD article! I briefly worked with them professionally some years back and learned to get on with them very well. Thanks for the suggestions which we'll keep in mind.

Continue to enjoy your electronics, and us!

LIFE OF BRYON REVISITED

Dear EPE,

About two years ago I resumed my electronics construction hobby after a break of thirty years, and was very pleased to discover *EPE*.

In response to Bryon Epps' query (Letter of the Month, Feb '04) about a magazine column featuring two fictional characters discussing circuit problems, the magazine in question was *The Radio Constructor* (later, *The Radio & Electronics Constructor*). The column was called "In Your Workshop", and the two individuals were "Smithy the Serviceman" and "his able assistant Dick". It was the first page I turned to when an eagerly awaited new issue arrived! I have a full set of issues from the 1960s and still enjoy reading them (plus many *Practical Wireless* and *Wireless World* from the same period).

Your readers might be amused by the following extract from my father's wartime edition of *The Amateur Radio Handbook* (2nd edn, RSGB, 1941, p.45):

"If all the components are to hand, spread them out on a sheet of drawing paper or piece of board slightly larger than the estimated chassis size. Play a game of chess with the components until all grid and plate leads are short, valves and condensers are out of the fields of coils, and RF chokes are in 'safe' positions. It will be necessary to play this game for the top of the chassis and also for the under side, remembering that the latter will be of the opposite hand. This sounds very simple, but neither the first nor the second attempt is likely to be satisfactory. Light a pipe and sit down to consider the result, then sweep all the parts to one side and do it again without trying to remember the previous arrangement..."

Lovely stuff!

Roger Parker,
via email

"Lovely stuff" indeed Roger – my beginnings in electronics were dominated by tagboards and valves, and the story rings true for me! For the sake of newbies, condenser *was the old word for* capacitor.

I too recall Smithy and Dick, but I'd forgotten their names and source – thanks for reminding us.

JAZZY NECKLACE

Dear EPE,

Regarding the *Jazzy Necklace* in your Feb '04 issue – you can see that kind of thing in every South Sea Hollywood epic but using bones or shark's teeth.

My teenage granddaughter says it is very uncool and an l.e.d. with fibre optics buried in clear plastic is a better bet (and cheaper). Personally, I would not rate it lasting an evening at a disco, and if it did the user would need treatment for cuts and abrasions.

Are you lot running out of ideas as we need more practical uses for electronics than that!

G.S.Chatley, via email

Oh GS, I am disappointed! We think that it is another good example of Thomas's imagination, and the response from other readers has been very encouraging. In case you didn't know, Thomas lives in South Africa and based the idea on rural art in his region. Whilst I know he has been to the South Seas, they were not his influence!

But projects don't just need to be useful, the fun of them is also beneficial and we try to entertain where appropriate, as well as inform.

JAZZY NECKLACE – THE MOVIE!

Did you spot when looking at our Home page (**www.epemag.wimborne.co.uk**) while the February '04 issue was current, that a movie clip of the *Jazzy Necklace* in colourful action was available for download? In case you missed it, you still have the ability to look. From our Home page, take the Projects page link, and under the Feb '04 issue details you'll find the click link access to it. The actual address is via **www.epemag.wimborne.co.uk/projects.html**.

Note, though, that you need Quicktime Movie Player software to be resident on your PC in order to run it.

REVOLUTIONARY PICKERY

Dear EPE,

I read the *Readout* March '04 letter from Martin Cox, Teaching Old Dogs, while waiting for my retirement presentation. I have been building radios since the 50s, first with valves and then with transistors when they became available.

My first adventures with micros were in the 70s: 8085, Z80 etc. However, since the start of the *EPE* PIC revolution I have more or less abandoned everything else in favour of these marvellous devices. So, thank you for *Toolkit* and all the other PICkery, keep more coming.

Anthony Langton,
Aberdeen, via email

Nice to hear from another "old dog" (I growl from nearly that era too!). Thanks, Anthony, for your kind words. And to reassure you, there's lots more PICery coming up, including Andrew Jarvis' PIC n' Mix *column, starting from next month!*

HONOURING EOCS

Dear EPE,

Thanks for another "Honourable Mention" of the Electronic Organ Constructors Society in your March issue. I suspect some members will go out and buy a copy when I mention it at the London Meeting in early April. Your maths was impeccable, but members set a booby trap a long time ago by having five meetings a year!

I attach a copy of the first page of the first-ever newsletter, just as a matter of interest.

Don Bray,
Editor, *Electronic Organ Magazine*,
via email

Thank you Don, we have always tried to mention EOCS from time to time – it's great that your passion should have had a good following for so many years.

It's interesting to have seen the newsletter – and to share a few snippets with readers: The first EOCS meeting took place on Saturday 28 May 1960, Room 45, Northern Polytechnic, Holloway Road, London.

"The Meeting starts at about 3 p.m. and finishes at 7 p.m. . . . If any members would like refreshments on the premises this can be arranged, but we must be notified in advance and the price is 2/- per head. There are, however, plenty of snack bars and restaurants in the vicinity, including a 'Lyons'".

"We are hoping Mr. Alan Douglas will be coming and bringing his organ, but there may be transport difficulties which will prevent him from bringing it, in which case we shall arrange for a member to bring his Home-built organ along. The whole of the proceedings will be recorded for the benefit of those members who live too far away to attend, including Mr. C.F. Mead of New Zealand who will definitely not be coming.

"We have now nearly 80 members. A few of these have not yet paid their £1 Annual Subscription, and whilst we realize that building an organ is a serious drain on the finance, we would very much like the cash."

That's a splendid bit of history! And such insights (and reminders) into the culture of the era . . . Lyons tea rooms, for instance (with their waitresses known as Nippies I recall), and refreshments for only 2/- (10p in modern coinage). Then the implications of "transport difficulties" – whilst the owning of cars was becoming a bit more commonplace by then, it was an era still dependent on buses and trains, and motor bikes, not to forget the scooters (Lambrettas, Vespas etc).

How too would the recording have been made? No such thing as video then. Could it have been on 8mm film, or even the luxury of 16mm? How about the sound? Domestic tape-recorders were just about in use at that time (Grundigs for example), but not in general use (and cassette recorders still undreamed of). But even now it's unlikely Mr Mead would be able to pop out from NZ for an evening's meeting in GB!

Fascinating, too, the statement that "there is room for a regular periodical dealing with the subject of amateur-built organs, and it is hoped that some enterprising publishers will one day discover this fact and bring out a periodical, in which case we could communicate with our members through this medium instead of issuing a newsletter". *Not quite predicting the coming of* Practical Electronics *(in which* EPE *partly has its origins) in 1964, but not far off it!*

To find our more about the EOCS, contact the Hon. Secretary, Trevor Hawkins, 23 Blenheim Road, St Albans, Herts AL1 4NS. Tel: 01727 857344. Web: ***http://eocs/org.uk.***

FLoPSI COMPETITION
(Dec. '03, Jan. '04)
Prizewinners have been notified, their names will be published next month.

PCB SERVICE

Printed circuit boards for most recent *EPE* constructional projects are available from the PCB Service, see list. These are fabricated in glass fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for *airmail* outside of Europe. Remittances should be sent to **The PCB Service, *Everyday Practical Electronics*, Wimborne Publishing Ltd., 408 Wimborne Road East, Ferndown, Dorset BH22 9ND. Tel: 01202 873872; Fax 01202 874562; Email: orders@epemag.wimborne.co.uk. On-line Shop: www.epemag.wimborne.co.uk/shopdoor.htm.** Cheques should be crossed and made payable to *Everyday Practical Electronics* **(Payment in £ sterling only).**
NOTE: While 95% of our boards are held in stock and are dispatched within seven days of receipt of order, please allow a maximum of 28 days for delivery – overseas readers allow extra if ordered by surface mail.
Back numbers or photostats of articles are available if required – see the *Back Issues* page for details. We do not supply kits or components for our projects.

Please check price and availability in the latest issue.
A large number of older boards are listed on our website.
Boards can only be supplied on a payment with order basis.

PROJECT TITLE		Order Code	Cost
~~★PIC Controlled Intruder Alarm~~	~~APR '02~~	~~339~~	~~£6.50~~
★PIC Big Digit Display	MAY '02	341	£6.02
Frequency Standard Generator – Receiver	JUNE '02	353	£4.12
– Digital		354	£6.82
★Biopic Heartbeat Monitor		355	£5.71
Simple Audio Circuits – 3	JULY '02		
– Dual Output Power Supply		356	£4.60
– Crossover/Audio Filter		357	£4.44
Infra-Red Autoswitch		358	£4.91
★EPE StyloPIC		359	£6.50
Rotary Combination Lock – Main Board		360	£5.39
– Interface Board		361	£4.91
★Using the PIC's PCLATH Command – **Software only**		–	–
Big-Ears Buggy	AUG '02	362	£5.71
★PIC World Clock		363	£5.39
Simple Audio Circuits–4 – Low Freq. Oscillator		364	£4.44
– Resonance Detector		365	£4.28
Vinyl-To-CD Preamplifier	SEPT '02	366	£5.71
★Freebird Glider Control		367	£4.91
★Morse Code Reader		368	£5.23
Headset Communicator	OCT '02	369	£4.75
EPE Bounty Treasure Hunter		370	£4.77
★★Digital I.C. Tester		371	£7.14
★PIC-Pocket Battleships – **Software only**		–	–
Transient Tracker	NOV '02	372	£4.75
★PICAXE Projects–1: Egg Timer; Dice Machine; Quiz Game Monitor (Multiboard)		373	£3.00
★Tuning Fork & Metronome		374	£5.39
★★EPE Hybrid Computer – Main Board } double-sided		375	£18.87
– Atom Board } double-sided		376	£11.57
★PICAXE Projects–2: Temperature Sensor; Voltage Sensor; VU Indicator (Multiboard)	DEC '02	373	£3.00
★Versatile PIC Flasher		377	£5.07
★PICAXE Projects–3: Chaser Lights	JAN '03	373	£3.00
6-Channel Mains Interface		381	£5.08
EPE Minder – Transmitter		378	£4.75
– Receiver		379	£5.39
★Wind Speed Monitor		380	£5.08
Tesla Transformer	FEB '03	382	£5.07
★Brainibot Buggy		383	£3.00
★Wind Tunnel		384	£6.02
200kHz Function Generator	MAR '03	385	£6.34
Wind-Up Torch Mk II		386	£4.75
★Driver Alert		387	£6.35
★Earth Resistivity Logger	APR '03	388	£6.02
★Intelligent Garden Lights Controller		389	£3.96
★PIC Tutorial V2 – **Software only**		–	–
Door Chime	MAY '03	390	£5.07
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Radio Circuits–1 MK484 TRF Receiver	JUNE '03	392	£4.44
Headphone Amp.		393	£4.28
★Fido Pedometer		394	£4.91
★PICronos L.E.D. Wall Clock		395	£14.65
EPE Mini Metal Detector	JULY '03	396	£4.28
Radio Circuits – 2 Q-Multiplier		397	£4.28
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Ultimate Egg Timer (Top Tenner)		403	£4.91
★EPE PIC Met Office	AUG '03	402	£10.46
Alarm System Fault Finder		404	£4.44
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Tuning Capacitor Board		406	£4.28
Master/Slave Intercom (Top Tenner)		407	£4.75
Two-Up (Top Tenner)		408	£4.91
Priority Referee (Top Tenner)	SEPT '03	410	£5.07
Vibration Alarm (Top Tenner)		411	£5.39
Radio Circuits–4 Varicap Tuner		412	£4.44
Coil Pack – General Coverage		413	£5.07
Coil Pack – Amateur Bands		414	£4.75
★PIC-A-Colour – **Software only**		–	–

PROJECT TITLE		Order Code	Cost
Spooky Bug (Top Tenner)	OCT '03	409	£5.07
Radio Circuits–5 Crystal Marker		415	£4.44
Super Regen. Receiver		419	£5.07
Buffer Amplifier		420	£4.44
★★Serial Interface for PICs and VB6		416	£5.23
★PIC Breakpoint – **Software only**		–	–
Anyone At Home – Logic Board	NOV '03	421 } Pair	£6.35
– Relay Board		422 } Pair	
Radio Circuits–6 Direct Conversion SW Receiver		423	£6.02
★PIC Random L.E.D. Flasher		424	£4.60
★PIC Virus Zapper Mk2	DEC '03	425	£5.72
Radio Circuits–7 SW Superhet Tuner/Mixer		426	£5.70
Christmas Cheeks (double-sided)		427	£4.44
★PIC Nim Machine – **Software only**		–	–
Bedside Nightlight (Top Tenner)	JAN '04		
Sound Trigger		417	£4.44
Timing/Lamp		418	£4.60
Radio Circuits–8 Dual Conversion SW Receiver			
I.F. Amp		428	£5.71
Signal-Strength Meter		429	£4.45
B.F.O./Prod. Detector		430	£4.75
★Car Computer (double-sided)		431	£7.61
★PIC Watering Timer – **Software only**		–	–
★GPS to PIC and PC Interface – **Software only**		–	–
Jazzy Necklace	FEB '04	432 pair	£5.40
Sonic Ice Warning		433	£5.39
★LCF Meter		434	£5.00
★PIC Tug-of-War		435	£5.00
Bat-Band Converter	MAR '04	436	£4.76
★MIDI Health Check – Transmitter/Receiver		437 pair	£7.61
Emergency Stand-by Light		438	£5.55
★PIC Mixer for RC Planes – **Software only**		–	–
★Teach-In '04 Part 5 – **Software only**		–	–
Infra-Guard	APR '04	439	£5.07
★EPE Seismograph Logger			
Control Board		440 } pair	£6.50
Sensor Amp. Board		441 } pair	
★Moon Clock		442	£5.71
★Teach-In '04 Part 6 – Software only		–	–

EPE SOFTWARE

Software programs for *EPE* projects marked with a single asterisk ★ are available on 3·5 inch PC-compatible disks or ***free*** from our Internet site. The following disks are available: **PIC Tutorial V2** (Apr-June '03); ***EPE* Disk 3** (2000); ***EPE* Disk 4** (2001 – excl. PIC Toolkit TK3); ***EPE* Disk 5** (2002); ***EPE* Disk 6** (2003 – excl. Earth Resistivity and Met Office); ***EPE* Disk 7** (Jan 2004 to current cover date); ***EPE* Earth Resistivity Logger** (Apr-May '03); ***EPE* PIC Met Office** (Aug-Sept '03); ***EPE* Seismograph** (Apr-May '04); ***EPE* Teach-In 2000; *EPE* Spectrum; *EPE* Interface Disk 1** (October '00 issue to current cover date). **EPE Toolkit TK3** software is available on the *EPE* PIC Resources CD-ROM, £14.45. Its p.c.b. is order code 319, £8.24. ★★The software for these projects is on its own CD-ROM. The 3·5 inch disks are £3.00 each (UK), the CD-ROMs are £6.95 (UK). Add 50p each for overseas surface mail, and £1 each for airmail. All are available from the *EPE PCB Service*. All files can be downloaded *free* from our Internet FTP site, accessible via our home page at: **www.epemag.wimborne.co.uk.**

EPE PRINTED CIRCUIT BOARD SERVICE

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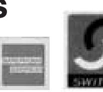
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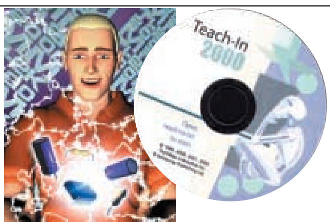
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http://www.epemag.wimborne.co.uk/shopdoor.htm

FREE *Electronics Hobbyist Compendium* book with Teach-In 2000 CD-ROM



EPE TEACH-IN 2000 CD-ROM

The whole of the 12-part *Teach-In 2000* series by John Becker (published in *EPE* Nov '99 to Oct 2000) is now available on CD-ROM. Plus the *Teach-In 2000* interactive software (Win 95, 98, ME and above) covering all aspects of the series and Alan Winstanley's *Basic Soldering Guide* (including illustrations and Desoldering).

Teach-In 2000 covers all the basic principles of electronics from Ohm's Law to Displays, including Op.Amps, Logic Gates etc. Each part has its own section on the interactive software where you can also change component values in the various on-screen demonstration circuits.

The series gives a hands-on approach to electronics with numerous breadboard circuits to try out, plus a simple computer interface (Win 95, 98, ME only) which allows a PC to be used as a basic oscilloscope.

ONLY **£12.45** including VAT and p&p

Order code Teach-In CD-ROM

DIRECT BOOK SERVICE

NOTE: ALL PRICES INCLUDE UK POSTAGE

The books listed have been selected by *Everyday Practical Electronics* editorial staff as being of special interest to everyone involved in electronics and computing. They are supplied by mail order to your door. Full ordering details are given on the last book page.

For a further selection of books see the next two issues of *EPE*.

Robotics

INTRODUCING ROBOTICS WITH LEGO MINDSTORMS
Robert Penfold

Shows the reader how to build a variety of increasingly sophisticated computer controlled robots using the brilliant Lego Mindstorms Robotic Invention System (RIS). Initially covers fundamental building techniques and mechanics needed to construct strong and efficient robots using the various "click-together" components supplied in the basic RIS kit. Then explains in simple terms how the "brain" of the robot may be programmed on screen using a PC and "zapped" to the robot over an infra-red link. Also, shows how a more sophisticated Windows programming language such as Visual BASIC may be used to control the robots.

Details building and programming instructions provided, including numerous step-by-step photographs.

288 pages – large format **Order code BP901** **£14.99**

MORE ADVANCED ROBOTICS WITH LEGO MINDSTORMS – Robert Penfold

Covers the Vision Command System

Shows the reader how to extend the capabilities of the brilliant Lego Mindstorms Robotic Invention System (RIS) by using Lego's own accessories and some simple home constructed units. You will be able to build robots that can provide you with 'waiter service' when you clap your hands, perform tricks, 'see' and avoid objects by using 'bats radar', or accurately follow a line marked on the floor. Learn to use additional types of sensors including rotation, light, temperature, sound and ultrasonic and also explore the possibilities provided by using an additional (third) motor. For the less experienced, RCX code programs accompany most of the featured robots. However, the more adventurous reader is also shown how to write programs using Microsoft's VisualBASIC running with the ActiveX control (Spirit.OCX) that is provided with the RIS kit.

Detailed building instructions are provided for the featured robots, including numerous step-by-step photographs. The designs include rover vehicles, a virtual pet, a robot arm, an 'intelligent' sweet dispenser and a colour conscious robot that will try to grab objects of a specific colour.

298 pages **Order code BP902** **£14.99**

ANDROIDS, ROBOTS AND ANIMATRONS – Second Edition – John Iovine

Build your own working robot or android using both off-the-shelf and workshop constructed materials and devices. Computer control gives these robots and androids two types of artificial intelligence (an expert system and a neural network). A lifelike android hand can be built and programmed to function doing repetitive tasks. A fully animated robot or android can also be built and programmed to perform a wide variety of functions.

The contents include an Overview of State-of-the-Art Robots; Robotic Locomotion; Motors and Power Controllers; All Types of Sensors; Tilt; Bump; Road and Wall Detection; Light; Speech and Sound Recognition; Robotic Intelligence (Expert Type) Using a Single-Board Computer Programmed in BASIC; Robotic Intelligence (Neutral Type) Using Simple Neural Networks (Insect Intelligence); Making a Lifelike Android Hand; A Computer-Controlled Robotic Insect Programmed in BASIC; Telepresence Robots With Actual Arcade and Virtual Reality Applications; A Computer-Controlled Robotic Arm; Animated Robots and Androids; Real-World Robotic Applications.

224 pages **Order code MGH1** **£16.99**

Radio

BASIC RADIO PRINCIPLES AND TECHNOLOGY
Ian Poole

Radio technology is becoming increasingly important in today's high technology society. There are the traditional uses of radio which include broadcasting and point to point radio as well as the new technologies of satellites and cellular phones. All of these developments mean there is a growing need for radio engineers at all levels.

Assuming a basic knowledge of electronics, this book provides an easy to understand grounding in the topic.

Chapters in the book: Radio Today, Yesterday, and Tomorrow; Radio Waves and Propagation; Capacitors, Inductors, and Filters; Modulation; Receivers; Transmitters; Antenna Systems; Broadcasting; Satellites; Personal Communications; Appendix – Basic Calculations.

263 pages **Order code NE30** **£18.99**

PROJECTS FOR RADIO AMATEURS AND S.W.L.S.
R. A. Penfold

This book describes a number of electronic circuits, most of which are quite simple, which can be used to enhance the performance of most short wave radio systems.

The circuits covered include: An aerial tuning unit; A simple active aerial; An add-on b.f.o. for portable sets; A wavetrap to combat signals on spurious responses; An audio notch filter; A parametric equaliser; C.W. and S.S.B. audio filters; Simple noise limiters; A speech processor; A volume expander.

Other useful circuits include a crystal oscillator, and RTTY/C.W. tone decoder, and a RTTY serial to parallel converter. A full range of interesting and useful circuits for short wave enthusiasts.

92 pages **Order code BP304** **£4.45**

AN INTRODUCTION TO AMATEUR RADIO
I. D. Poole

Amateur radio is a unique and fascinating hobby which has attracted thousands of people since it began at the turn of the century. This book gives the newcomer a comprehensive and easy to understand guide through the subject so that the reader can gain the most from the hobby. It then remains an essential reference volume to be used time and again. Topics covered include the basic aspects of the hobby, such as operating procedures, jargon and setting up a station. Technical topics covered include propagation, receivers, transmitters and aerials etc.

150 pages **Order code BP257** **£5.49**

VALVE RADIO AND AUDIO REPAIR HANDBOOK (Second Edition) Chas Miller

This book is not only an essential read for every professional working with antique radio and gramophone equipment, but also dealers, collectors and valve technology enthusiasts the world over. The emphasis is firmly on the practicalities of repairing and restoring, so technical content is kept to a minimum, and always explained in a way that can be followed by readers with no background in electronics. Those who have a good grounding in electronics, but wish to learn more about the practical aspects, will benefit from the emphasis given to hands-on repair work, covering mechanical as well as electrical aspects of servicing. Repair techniques are also illustrated throughout.

A large reference section provides a range of information compiled from many contemporary sources, and includes specialist dealers for valves, components and complete receivers.

270 pages **Order code NE34** **£23.99**

Computers and Computing

THE INTERNET FOR THE OLDER GENERATION
Jim Gatenby

Especially written for the over 50s. Uses only clear and easy-to-understand language. Larger type size for easy reading. Provides basic knowledge to give you confidence to join the local computer class.

This book explains how to use your PC on the Internet and covers amongst other things: Choosing and setting up your computer for the Internet. Getting connected to the Internet. Sending and receiving emails, photographs, etc., so that you can keep in touch with family and friends all over the world. Searching for and saving information on any subject. On-line shopping and home banking. Setting up your own simple web site.

228 pages **Order code BP600** **£8.99**

HOW TO BUILD YOUR OWN PC – Third Edition
Morris Rosenthal

More and more people are building their own PCs. They get more value for their money, they create exactly the machine they want, and the work is highly satisfying and actually fun. That is, if they have a unique beginner's guide like this one, which visually demonstrates how to construct a state-of-the-art computer from start to finish.

Through 150 crisp photographs and clear but minimal text, readers will confidently absorb the concepts of computer building. The extra-big format makes it easy to see what's going on in the pictures. For non-specialists, there's even a graphical glossary that clearly illustrates technical terms. The author goes "under the hood" and shows step-by-step how to create a socket 7 (Pentium and non-intel chipsets) and a Slot 1 (Pentium II) computer, covering: What first-time builders need to know; How to select and purchase parts; How to assemble the PC; How to install Windows 98. The few existing books on this subject, although badly outdated, are in steady demand. This one delivers the expertise and new technology that fledgling computer builders are eagerly looking for.

224 pages – large format **Order code MGH2** **£20.99**

PIC YOUR PERSONAL INTRODUCTORY COURSE SECOND EDITION John Morton

Discover the potential of the PIC microcontroller through graded projects – this book could revolutionise your electronics construction work!

A uniquely concise and practical guide to getting up and running with the PIC Microcontroller. The PIC is one of the most popular of the microcontrollers that are transforming electronic project work and product design.

Assuming no prior knowledge of microcontrollers and introducing the PIC's capabilities through simple projects, this book is ideal for use in schools and colleges. It is the ideal introduction for students, teachers, technicians and electronics enthusiasts. The step-by-step explanations make it ideal for self-study too: this is not a reference book – you start work with the PIC straight away.

The revised second edition covers the popular reprogrammable EEPROM PICs: P16C84/16F84 as well as the P54 and P71 families.

270 pages **Order code NE36** **£15.99**

UNDERSTANDING PC SPECIFICATIONS
R. A. Penfold (Revised Edition)

PCs range from simple systems of limited capabilities up to complex systems that can happily run applications that would have been considered beyond the abilities of a microcomputer not so long ago. It would be very easy to choose a PC system that is inadequate to run your applications efficiently, or one which goes beyond your needs and consequently represents poor value for money.

This book explains PC specifications in detail, and the subjects covered include the following: Differences between types of PC (XT, AT, 80386, etc); Maths co-processors; Input devices (keyboards, mice, and digitisers); Memory, including both expanded (EMS) and extended RAM; RAM disks and disk caches; Floppy disk drive formats and compatibility; Hard disk drives (including interleave factors and access times); Display adaptors, including all standard PC types (CGA, Hercules, Super VGA, etc); Contains everything you need to know if you can't tell your EMS from your EGA!

128 pages **Order code BP282** **£5.45**

Theory and Reference

BEBOP TO THE BOOLEAN BOOGIE
Second Edition
Clive (call me Max) Maxfield

This book gives the "big picture" of digital electronics. This indepth, highly readable, up-to-the-minute guide shows you how electronic devices work and how they're made. You'll discover how transistors operate, how printed circuit boards are fabricated, and what the innards of memory ICs look like. You'll also gain a working knowledge of Boolean Algebra and Karnaugh Maps, and understand what Reed-Muller logic is and how it's used. And there's much, MUCH more. The author's tongue-in-cheek humour makes it a delight to read, but this is a REAL technical book, extremely detailed and accurate.

Contents: Fundamental concepts; Analog versus digital; Conductors and insulators; Voltage, current, resistance, capacitance and inductance; Semiconductors; Primitive logic functions; Binary arithmetic; Boolean algebra; Karnaugh maps; State diagrams, tables and machines; Analog-to-digital and digital-to-analog; Integrated circuits (ICs); Memory ICs; Programmable ICs; Application-specific integrated circuits (ASICs); Circuit boards (PWBs and DWBs); Hybrids; Multichip modules (MCMs); Alternative and future technologies.

500 pages **Order code BEB1** **£27.50**

BEBOP BYTES BACK (and the Bebopuer Computer Simulator) CD-ROM
Clive (Max) Maxfield and Alvin Brown

CD-ROM

This follow-on to *Bebop to the Boolean Boogie* is a multimedia extravaganza of information about how computers work. It picks up where "Bebop I" left off, guiding you through the fascinating world of computer design . . . and you'll have a few chuckles, if not belly laughs, along the way. In addition to over 200 megabytes of mega-cool multimedia, the CD-ROM contains a virtual microcomputer, simulating the motherboard and standard computer peripherals in an extremely realistic manner. In addition to a wealth of technical information, myriad nuggets of trivia, and hundreds of carefully drawn illustrations, the CD-ROM contains a set of lab experiments for the virtual microcomputer that let you recreate the experiences of early computer pioneers. If you're the slightest bit interested in the inner workings of computers, then don't dare to miss this!

Over 800 pages in Adobe Acrobat format

CD-ROM **Order code BEB2 CD-ROM** **£21.95**

ELECTRONICS MADE SIMPLE
Ian Sinclair

Assuming no prior knowledge, *Electronics Made Simple* presents an outline of modern electronics with an emphasis on understanding how systems work rather than on details of circuit diagrams and calculations. It is ideal for students on a range of courses in electronics, including GCSE, C&G and GNVQ, and for students of other subjects who will be using electronic instruments and methods.

Contents: waves and pulses, passive components, active components and ICs, linear circuits, block and circuit diagrams, how radio works, disc and tape recording, elements of TV and radar, digital signals, gating and logic circuits, counting and correcting, microprocessors, calculators and computers, miscellaneous systems.

199 pages **Order code NE23** **£13.99**

SCROGGIE'S FOUNDATIONS OF WIRELESS AND ELECTRONICS – ELEVENTH EDITION
S. W. Amos and Roger Amos

Scroggie's Foundations is a classic text for anyone working with electronics, who needs to know the art and craft of the subject. It covers both the theory and practical aspects of a huge range of topics from valve and tube technology, and the application of cathode ray tubes to radar, to digital tape systems and optical recording techniques.

Since *Foundations of Wireless* was first published over 60 years ago, it has helped many thousands of readers to become familiar with the principles of radio and electronics. The original author Sowerby was succeeded by Scroggie in the 1940s, whose name became synonymous with this classic primer for practitioners and students alike. Stan Amos, one of the fathers of modern electronics and the author of many well-known books in the area, took over the revision of this book in the 1980s and it is he, with his son, who have produced this latest version.

400 pages **Order code NE27** **£23.99**

GETTING THE MOST FROM YOUR MULTIMETER
R. A. Penfold

This book is primarily aimed at beginners and those of limited experience of electronics. Chapter 1 covers the basics of analogue and digital multimeters, discussing the relative merits and the limitations of the two types. In Chapter 2 various methods of component checking are described, including tests for transistors, thyristors, resistors, capacitors and diodes. Circuit testing is covered in Chapter 3, with subjects such as voltage, current and continuity checks being discussed.

In the main little or no previous knowledge or experience is assumed. Using these simple component and circuit testing techniques the reader should be able to confidently tackle servicing of most electronic projects.

96 pages **Order code BP239** **£5.49**

THE AMATEUR SCIENTIST CD-ROM

CD-ROM

The complete collection of The Amateur Scientist articles from *Scientific American* magazine. Over 1,000 classic science projects from a renowned source of winning projects. All projects are rated for cost, difficulty and possible hazards.

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Music, Audio and Video

QUICK GUIDE TO ANALOGUE SYNTHESIS
Ian Waugh

Even though music production has moved into the digital domain, modern synthesisers invariably use analogue synthesis techniques. The reason is simple – analogue synthesis is flexible and versatile, and it's relatively easy for us to understand. The basics are the same for all analogue synths, and you'll quickly be able to adapt the principles to any instrument, to edit existing sounds and create exciting new ones. This book describes: How analogue synthesis works; The essential modules every synthesiser has; The three steps to synthesis; How to create phat bass sounds; How to generate filter sweeps; Advanced synth modules; How to create simple and complex synth patches; Where to find soft synths on the Web.

If you want to take your synthesiser – of the hardware or software variety – past the presets, and program your own sounds and effects, this practical and well-illustrated book tells you what you need to know.

60 pages **Order code PC118** **£7.45**

QUICK GUIDE TO MP3 AND DIGITAL MUSIC
Ian Waugh

MP3 files, the latest digital music format, have taken the music industry by storm. What are they? Where do you get them? How do you use them? Why have they thrown record companies into a panic? Will they make music easier to buy? And cheaper? Is this the future of music?

All these questions and more are answered in this concise and practical book which explains everything you need to know about MP3s in a simple and easy-to-understand manner. It explains:

How to play MP3s on your computer; How to use MP3s with handheld MP3 players; Where to find MP3s on the Web; How MP3s work; How to tune into Internet radio stations; How to create your own MP3s; How to record your own CDs from MP3 files; Other digital audio music formats.

Whether you want to stay bang up to date with the latest music or create your own MP3s and join the on-line digital music revolution, this book will show you how.

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R. A. Penfold

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During the Second World War, Alan Blumlein was deeply engaged in the very secret work of radar development and contributed enormously to the system eventually to become 'H25' – blind-bombing radar. Tragically, during an experimental H2S flight in June 1942, the Halifax bomber in which Blumlein and several colleagues were flying, crashed and all aboard were killed. He was just days short of his thirty-ninth birthday.

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